

# ANNALS OF SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

EDITED BY  
LEWIS STEPHEN PILCHER, M.D., LL.D.,  
OF NEW YORK

WITH THE ASSOCIATION OF  
JAMES TAFT PILCHER, B.A., M.D.,  
AND THE COLLABORATION OF  
W. SAMPSON HANDLEY, M.S., M.D., F.R.C.S.,  
OF LONDON.

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## OBSERVATIONS REGARDING VENTRICULAR PUNCTURES

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VENTRICULAR punctures have been used in the diagnosis and treatment of internal hydrocephalus ever since the time of Hippocrates. The patients so treated were invariably young children of such an early age that the anterior fontanelle had not closed and the repeated ventricular punctures were made at the lateral angle of the open fontanelle so that the needle could be easily inserted into the greatly dilated lateral ventricle at a safe distance from the longitudinal sinus and without the necessity of making a bony opening. This method of treatment of internal hydrocephalus was naturally of little, if any, value, as it did not in any conceivable manner remove the cause of the blockage of the ventricles and therefore the blocked cerebrospinal fluid would again refill and dilate the ventricles, necessitating another tapping and so on until usually an infection and its resulting purulent meningitis would cause the death of the patient.

*Combined Ventricular-lumbar Punctures.*—Ventricular punctures have also been used diagnostically in recent years in cases of suspected internal hydrocephalus in order to inject into the lateral ventricle a small measured quantity of some harmless coloring substance, usually phenolsulphonaphthalein, and then to ascertain the time necessary for it to appear in the urine and the total amount so excreted; if no blockage of the ventricles was present, then the time of its appearance in the urine and its total amount would be within the normal limit of ten minutes, but if a complete blockage of the ventricles was present and since there is practically no absorption of cerebrospinal fluid in the ventricles, then little or no coloring substance would appear in the urine even within a period of one hour. This test is by no means an accurate one as the ventricles themselves may not be blocked and yet the important excretory channels of the cerebrospinal fluid through the walls of the supracortical veins, through which over 80 per cent. of the cerebrospinal fluid is normally excreted, may themselves be blocked by the organization-residue of former meningeal exudate or of unabsorbed supracortical layer of hemorrhage and in this manner the appearance of the coloring substance in the urine may be long delayed and its quantity greatly reduced even to a degree of suggesting a partial blockage of the ventricles; in fact, many cranial operations have been devised and performed in the past to drain a supposed internal hydrocephalus when no such blockage existed, but rather an external hydrocephalus was present.

In order to facilitate the diagnosis in these cases, combined ventricular-



lumbar punctures were made by which a harmless coloring substance would be injected into the lateral ventricle and the time of its appearance in the lumbar spinal canal would be registered and also the total quantity so recovered; the normal time of its passage from the ventricles to the lumbar portion of the spinal canal was considered within three minutes. This method, however, merely demonstrated a ventricular blockage or not, so that usually the time of its appearance at the lumbar puncture needle was simply noted and if within normal limits showing that the ventricles were not blocked, then the lumbar puncture needle was immediately removed and the time of the appearance of the coloring substance in the urine and the amount of the total recovery were carefully noted in order to demonstrate the presence or not of an external hydrocephalus due to a blockage of the channels of excretion of the cerebrospinal fluid through the walls of the supracortical veins, sinuses, Pacchionian bodies, etc.

However, in this combined ventricular-lumbar puncture test, the presence or not of ventricular blockage was easily determined by placing the patient upon either side in a horizontal position with the spinal canal upon the same level plane as the median line or longitudinal sinus of the head; then, the patient being perfectly quiet, the pressure in the ventricle was accurately measured by connecting its needle with a manometer and then the pressure in the spinal canal was similarly obtained; in this manner, if the ventricles were blocked, then the ventricular pressure would ordinarily be higher than the spinal pressure and if not blocked, then both pressure readings should be the same. Another valuable observation could also be made: removing the stylet from each needle, the rate of flow or dropping of the cerebrospinal fluid should be the same if no blockage of the ventricles existed, and naturally if no blockage in the upper portion of the spinal canal was present which could be easily demonstrated by the Queckenstedt test (bilateral-jugular compression producing a normal rise of pressure at the lumbar puncture needle). If the ventricles were blocked, then the rate of flow of the cerebrospinal fluid from the ventricular needle would be just so much faster according to the degree of ventricular pressure and blockage.

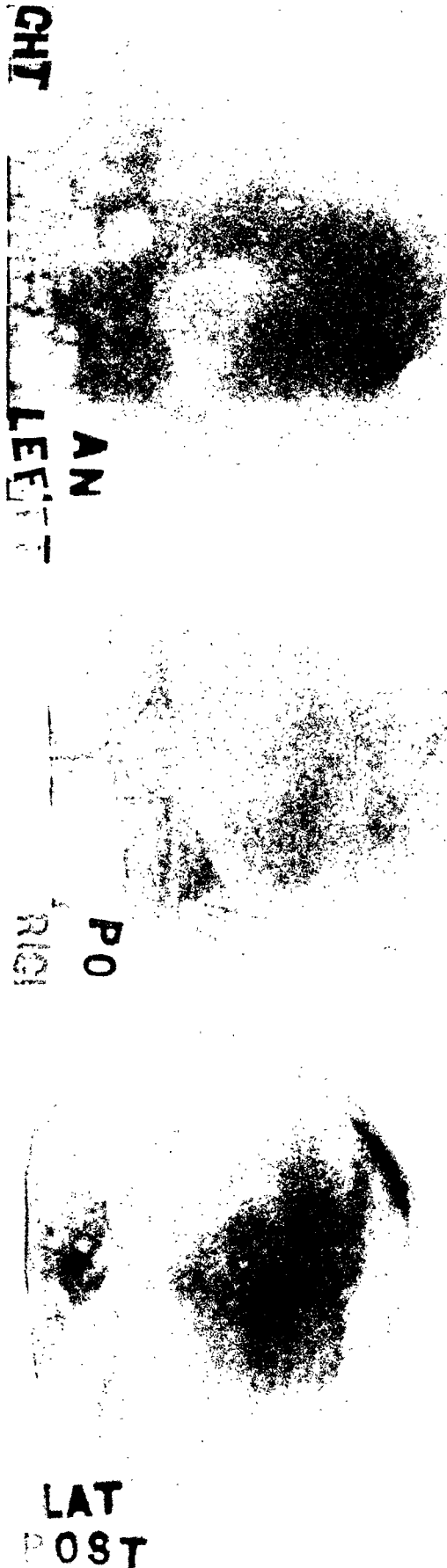
*Ventricular Estimations and Röntgenograms.*—The above ventricular puncture tests are thus seen to have been limited almost entirely to the diagnosis and treatment of the condition of hydrocephalus and particularly in children in whom the dilated ventricles had enlarged the head, and it was not until Dandy in 1921 suggested the advisability of ventricular estimations and röntgenograms in the diagnosis and localization of gross lesions of the brain that any other use of ventricular tests was made. At times, in order to localize a doubtful brain tumor as being above or below the tentorium, then a ventricular puncture through the corpus callosum or into the lateral ventricles was performed in the past to ascertain the presence or not of ventricular dilatation: if present, then the tumor was most probably posterior basally or subtentorially in order that a blockage of the ventricles could result, but as a rule this preliminary test was rarely made as a subtentorial lesion usually disclosed its presence by the characteristic signs of cerebellar involve-

## VENTRICULAR PUNCTURES

ment. (Fig. 1, a, b, c.) In the literature, there are several cases of air being reported as disclosed in the ventricles by röntgenograms following fractures of the skull, particularly those fractures in the frontal area through the ethmoidal cells or into the frontal sinuses, but no practical application was suggested by this phenomenon until Dandy presented his valuable contribution to this field of cerebral localization, in adults as well as in children.

In suspected cases of gross non-localized cerebral lesions that can be treated surgically, such as tumor and abscess formations, and the entire neurological armamentarium having been exhausted in efforts to localize the surgically removable lesion, then it is the opinion of this clinic that it is not only justifiable but obligatory upon the surgeon to use this method of ventricular estimations and röntgenograms in the hope that the cerebral lesion can be accurately localized and thus an opportunity be given to the patient of its successful removal. On the other hand, it is the opinion of this clinic that no

FIG. 1.



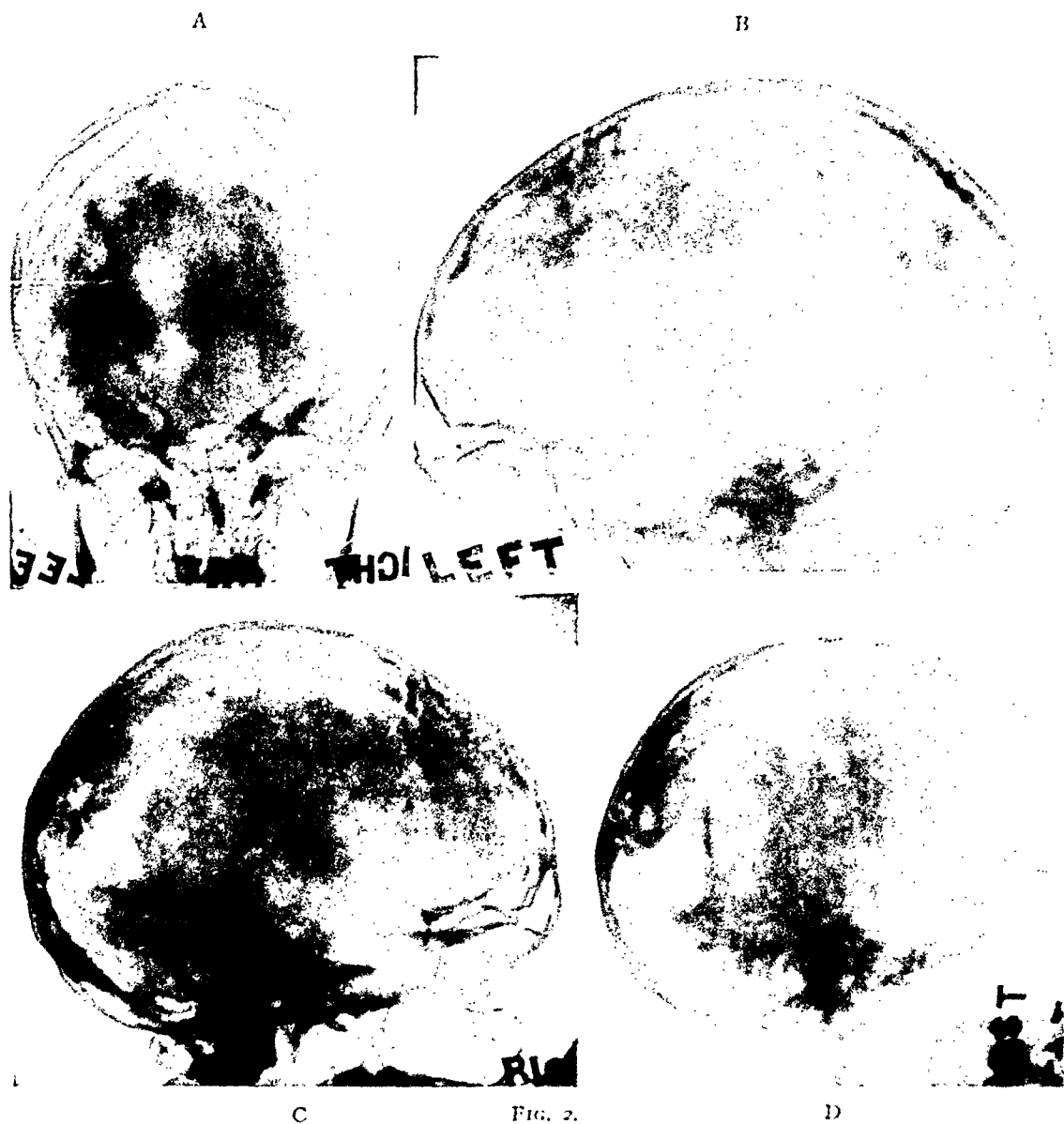
patient should be subjected to the permanent cerebral damage and its very possible future complications of cortical irritability and emotional instability, even to the degree of convulsive seizures, by the passage of the puncture needle through the cerebral tissues of the cortex into the ventricles, unless all neurological examinations and tests have failed to determine the localization of the lesion, and if the presence of a surgically removable lesion, such as tumor or abscess formation, is more than just a probable one. That is, to perform the ventricular estimations and röntgenograms as an early neurological examination without having exhausted every means to determine the cerebral localization, and especially the use of this test upon patients in the absence of a marked increase of the intracranial pressure and in whom the probability of a surgically removable lesion is very doubtful, and particularly in such patients already subject to convulsive seizures of cortical irritability—it is this careless and indiscriminate use of ventricular estimations that is not only dangerous to future normality of these patients, but it tends to discredit legitimate use of a most valuable test in *selected* cases.

Besides the immediate cerebral damage incidental to the ventricular puncture by the blunt trochar as it penetrates the occipital lobe toward and into the posterior horn of the lateral ventricle—and this cellular damage of brain tissue is not merely a possibility or a theoretical one, but *occurs each time this test is made*, and especially so when several cortical punctures are frequently necessary in order to locate the ventricle, and even though its signs may not appear clinically until weeks or months later, there is also a reported mortality from the test itself from various clinics of almost 10 per cent.; in this clinic the mortality following the test has been 8.4 per cent. This mortality, however, should become lower as greater care is taken to avoid sudden marked changes in the ventricular pressure by the withdrawal at any one time of only a small amount of ventricular cerebrospinal fluid—not over 5 c.c., and by its immediate replacement with an equal amount of air until the usual amount of 15–20 c.c. of air has replaced an equal amount of cerebrospinal fluid and not under a higher pressure than was originally present in the ventricles; in this manner, no sudden change of the ventricular pressure has occurred and thus is lessened the great danger of hemorrhage into a large tumor mass from its poorly supported and often diseased blood-vessels, or of precipitating an acute cerebral and then medullary oedema following a marked change in a high intracranial pressure, to which the intracranial vascular system had accustomed and slowly adjusted itself over a period of months during the growth of the tumor or abscess formation. In three of the cases in this series at necropsy, two disclosed a large hemorrhage of almost the size of an orange in extensive gliomatous tumors and neoplasms were situated in the right frontal area far from the ventricular puncture which was performed into the posterior horn of the left ventricle, and the remaining one disclosed an acute cerebral and resulting medullary oedema in the case of a large endothelioma in the right temporosphenoidal lobe.

In six patients from whom at later operation large cerebral tumors were removed in whole or in part, within twenty-four hours following the ven-

## VENTRICULAR PUNCTURES

tricular estimations and röntgenograms occurred a marked increase of the intracranial pressure to a degree that retinal hemorrhages appeared as the oedematous swelling of the optic disks became greater with an associated severe headache; in three of these patients, drowsiness to even stupor persisted for forty-eight hours and then gradually subsided as the acute cerebral



oedema resulting from the cerebral punctures themselves or from the alteration of the ventricular pressure lessened in severity. (Fig. 2, a, b, c, d.)

Naturally, in the absence of large intracranial lesions producing a high intracranial pressure and in the presence of only a slight ventricular blockage and dilatation, then the immediate risk of life of ventricular estimations and röntgenograms is a slight one, as the resulting alterations of intracranial pressure due to the test would necessarily be little, if any. This observation applies equally to those suspected and doubtful cases of surgically removable lesions and yet no such lesion is demonstrated by the test or even at later exploratory operation; however, these latter patients are just the ones upon whom the test should rarely if ever be performed as there is no definite increase in the

intracranial pressure, and it is the performance of the test upon these non-surgical cases in those clinics that report such a low mortality—one or two per cent. and even no mortality! It would indeed be interesting to ascertain the statistics in these clinics of the end results of all their patients subjected to ventricular estimations and röntgenograms and thus to realize the low percentage of surgically removable lesions in these patients. To perform this serious test, fraught with danger to life as well as to future normality, upon patients and no lesion amenable to surgical treatment is found, then the patient, to say the least, has not been benefitted by the procedure and such operative tests merely tend to discredit the rational use of a most valuable aid in the diagnosis and localization of selected surgically removable lesions. Cerebral tissues can in no way be compared with liver or muscle tissue or with the tissues of the chest or abdominal wall, and although such puncturing of cerebral tissues causes permanent damage that may not be evident by clinical tests, yet the emotional reactions and the personality of the patient may be gravely altered. Surely if the patient cannot be benefitted by surgical procedures, then at least no examinations and no tests should be employed that may make the condition of the patient worse. These so-called doubtful cases are just the ones in whom repeated attempts to utilize injection of air for ventricular and supracortical röntgenograms by means of lumbar puncture route with patient in sitting position or by cisterna magna route would be eminently justified; patient would at least not be damaged by the tests and when this method is successful in permitting injected air to pass into ventricles or over cortex, then the röntgenograms are equally satisfactory.

In one clinic, essential or so-called idiopathic epilepsy is apparently considered amenable to cranial surgery and upon these sufferers of a cellular degenerative process, this test of ventricular estimations and röntgenograms is performed as a part of the routine neurological examinations, and if there be either a so-called ventricular "hypotension" or even a mild ventricular hypertension—so often associated with the "wet" cerebral œdemas resulting from and secondary to the convulsive seizures themselves, then an osteoplastic "flap" operation is performed to alter such ventricular variation of pressure! To insert a ventricular trochar through brain tissue already in such an irritable condition as to permit convulsive seizures to occur and then to believe that any cranial and cerebral operative procedure can in any conceivable manner permanently affect the degenerative cellular process—such an attitude is, at best, a metaphysical one, and if such a practice should become a general one, then neurosurgery would be rightly classed with the discarded specialties of alchemy and astrology.

The rational use of the test of ventricular estimations and röntgenograms makes possible the accurate localization of many cerebral tumors and even cerebral abscesses in selected cases that otherwise could not be determined except by means of an exploratory operation, if even then successful. The majority of gross cerebral lesions can be definitely localized by the usual neurological examinations and these are the patients that should not be subjected to the additional cerebral trauma of ventricular punctures; but there is

a small percentage of patients having intracranial lesions amenable to surgical treatment that cannot be localized with any degree of accuracy even after repeated and most careful neurological examinations, and these are the patients and only the ones that should be given the opportunity of having the lesion definitely outlined by means of ventricular röntgenograms. It must be remembered, however, that even this method of ventricular diagnosis often fails to indicate the site of the tumor—especially the presence of small tumor formations in or protruding into the cerebral cortex and particularly is this more frequent in either frontal or temporosphenoidal lobe—the comparatively silent areas of the brain in the right hemisphere in right-handed patients. It is indeed surprising, however, to note the slight dislocation of the lateral ventricles to or from the median line, and forward, backward, upward or downward, even in the presence of an apparently small cortical tumor of the infiltrating gliomatous type, and also the definite indentation and even constriction of the adjacent horn of the ventricle in the presence of small tumors causing an indirect rather than a direct ventricular pressure. It is even possible to have a mild degree of bilateral ventricular dilatation in presence of small frontal tumor due most probably to associated cerebral oedema causing downward pressure upon brain stem sufficient to block normal escape of cerebrospinal fluid through aqueduct of Sylvius or more probably from foramina of Majendie and Luschka of fourth ventricle.

Yet the careful study and correct interpretation of the ventricular röntgenograms will make possible the accurate localization of many surgically removable lesions of the brain that otherwise might be overlooked entirely even after several exploratory operations, and therefore this notable contribution by Dandy marks another epoch in the advance of neurosurgery. It is being more and more realized, however, that ventricular estimations and röntgenograms will not aid in all cases of unlocalized tumor and abscess formations, and that the test should be performed only in selected cases necessitating its use; that practically four-fifths of brain tumors are malignant in that they recur even after their successful removal and that the operative mortality of true brain abscess within cerebral or cerebellar tissue is still almost 70 per cent., even when localized comparatively early! In this connection, it is important to emphasize the necessity of great care in advising and in performing the ventricular estimations and röntgenograms in the presence of a possible meningitis or meningoencephalitis; to make the ventricular punctures through the cerebral cortex in the hope of localizing the abscess formation and there is present a meningeal inflammatory process so frequently co-existent with it, then the danger of producing a purulent encephalitis and multiple brain abscesses is very great indeed; also the wet oedematous brain associated with encephalitis and so often mistaken for cerebral tumor that the condition is known as one of “pseudo-tumor”—to perform a ventricular puncture on these patients merely increases both the cerebral oedema and the great danger of an extension of the cortical process to the deeper subcortical tissues—and with no benefit to the patients, to say the least.

# SPONGIOBLASTOMA MULTIFORME OF THE BRAIN

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VIRCHOW<sup>1</sup> was perhaps the first to identify a large group of intracranial tumors which have their origin from the glial tissue of the brain. He described such neoplasms as slow-growing, infiltrating, vascular masses which are prone to contain hemorrhages, cysts and large areas of degeneration. He



FIG. 1.—Coronal section of brain showing extensive cystic and hemorrhagic degeneration in the tumor which practically replaced the cortical tissue.

gave the name *glioma* to these new growths. At present such tumors are considered to be of ectodermal origin and to consist of glial cells and extracellular fibres. They are said to be found only in the central nervous system and its outgrowths, such as the retina.

Until recently, the rather inclusive and ill-defined term *glioma* has been given to all intracranial tumors to which Virchow's description applied. It may be realized how large a group of neoplasms came under this heading when it is remembered that gliomas constitute about forty per cent. of all intracranial new growths. That many of these tumors exhibit a gross pathological appearance and a clinical course which are entirely different from those of other growths in the same category had been recognized by many neurologic surgeons. It has remained for Cushing and Bailey,<sup>2</sup> however, to furnish a microscopical differentiation which may be correlated with the clinical course of the lesion. This has been done by the application of many of the gold and silver staining methods developed by Cajal and his school.

Such a study has furnished a means of reclassifying and subdividing the large number of gliomas into smaller groups, each with its characteristic gross pathological, microscopical and clinical picture. That such a reidentification should have for its basic principle the normal histogenesis of the brain seems only logical and natural. It has allowed these authors to identify in Cushing's series of intracranial tumors practically every cellular type found in the development of the central nervous system. Their work has afforded a definite and invaluable step forward in the surgical treatment of this large group of tumors of glial origin.

It will be remembered that the medullary plate, from which the central nervous system develops, consists primarily of one layer of columnar epithelial cells known as the medullary epithelium. From this layer three types of cells may develop: (1) primitive spongioblasts, (2) medulloblasts or indifferent cells and (3) neuroblasts. The *primitive spongioblast*, in the

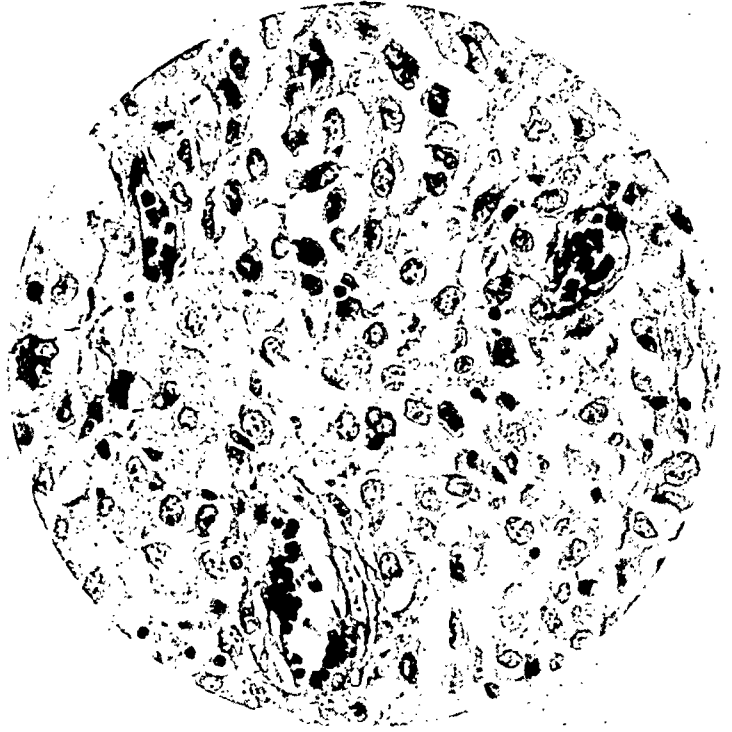


FIG. 2.—Section of tumor mass removed from brain. Blood-vessels show proliferation of endothelium and tumor cells appear to invade lumen. Alzheimer stain  $\times 380$ .

course of its normal development, passes through a bipolar and unipolar stage to the astroblast which is the immediate forerunner of the adult fibrillary and protoplasmic astrocyte. The *medulloblast* or indifferent cell, as its name implies, has no prescribed line of development but may become either a glia or a nerve cell. The *neuroblast* passes through a series of stages like the spongioblast and eventually forms the adult nerve cell. As stated before, Cushing and Bailey have identified tumors arising from these cells in practically every stage of their development.

Globus and Strauss<sup>3</sup> and later Ribbert<sup>4</sup> proposed the name *spongioblastoma* for a large group of tumors whose cells are of neuroglial origin, and the qualifying adjective *multiforme* because their striking feature is their multiform appearance. Many of the cells are multinucleated and represent true giant cells. The amount of cytoplasm varies greatly while the nuclei are of various sizes and shapes and contain a variable amount of chromatin. In Cushing's large series of intracranial neoplasms the spongioblastoma multiforme was found most often.



It is known that some of these neuroglial tumors may be accompanied by multiple primary growth centres situated at some distance from one another within the brain. It is recognized also that the medulloblastoma may become disseminated through the subarachnoid spaces where, upon implantation, it loses its original characteristics. It is questionable, however, whether either of these processes constitute what is recognized as metastatic growth. That carcinoma of many viscera commonly metastasize to the central nervous system is well known, but a metastatic growth formed from a primary focus in

the brain and situated at a distance and within fundamentally different tissue is a pathological entity which assumes clinical importance because of its rarity.

Such an instance was met during the clinical course of the patient whose history is given in abstract:

*Rapid onset of intracranial symptoms. Operation and removal of an apparently enucleable tumor from the left temporal lobe. Improvement in the symptoms. X-ray therapy. Progression of the symptoms. Second operation with removal of eighty grams of tumor tissue. Death three months later.*

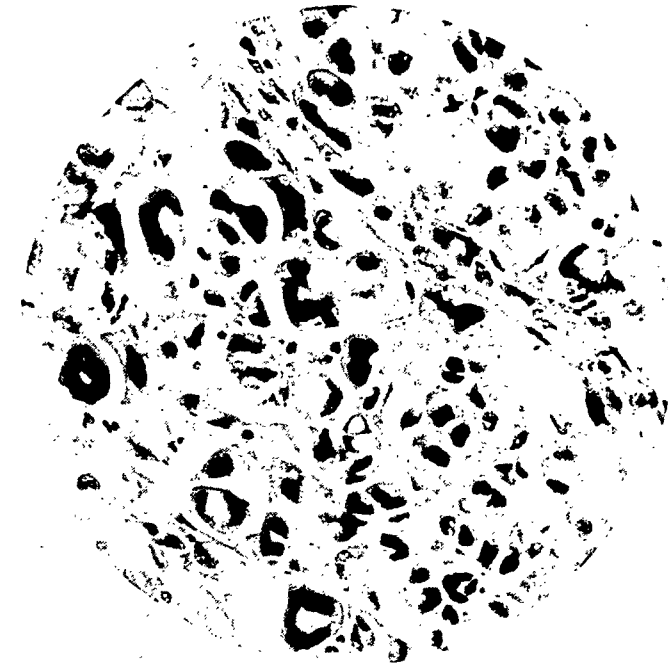


FIG. 3.—Section of tumor mass from brain showing multinucleated cells and division of cells. Mallory phosphotungstic acid-hematoxylin stain  $\times 380$ .

*Necropsy.* Spongioblastoma multiforme with metastases in the right arm, left lung and the soft tissues over the right scapula and the left costal margin.

*History.*—K. K., aged thirty-one years, was referred by Dr. H. A. Richter, of Evanston, Illinois, and entered Wesley Memorial Hospital on January 10, 1926.

The patient was a concert pianist and felt quite well until October, 1925. She then noticed that she was playing the piano poorly because she could not take in a large sweep of notes at one glance. This made her playing uneven, irregular and choppy. In order to read ahead, it became necessary for her to turn her head in short movements to the right. After a time, which was very indefinite in her mind, she noted that she had diplopia. The false image alternately faded away and came back into her field of vision. Soon she developed a frontal headache which was very marked and was accompanied by vomiting.

These events occurred between October and December 25, 1925. She then was fitted for glasses, but three changes of lenses failed to give relief. About January 1, 1926, she first noted difficulty in saying words and in completely verbalizing her train of thought.

*Examination.*—There was a high degree of papilloedema in both fundi, and both blind spots were greatly enlarged. A right homonymous hemianopsia was quite evident. This was complete to the median line. There were never any hallucinations of light or

form in either the hemianopic or normal field. There was weakness of the left external rectus muscle and a ptosis of the left upper eyelid. There was no weakness of the right arm or leg and no sensory changes over the body. The patient had an incomplete verbal, nominal and semantic aphasia.

*Course.*—On January 14, 1926, an osteoplastic flap was made to expose the left temporal and parietal lobes and the posterior portion of the frontal lobe. A circumscribed tumor mass was found to occupy the posterior portion of the superior and middle temporal convolutions and the inferior portion of the parietal lobe. This was two centimetres beneath the surface of the cortex. The mass was separated from the surrounding cortical tissue by moist cotton pledget dissection. The portion of the tumor delivered was about the size of a large hen's egg. At its base the line of demarcation became indistinct and this edge of the mass removed was irregular. The remaining cavity was treated with Zenker's solution. A decompression opening was left in the flap which was replaced.

The patient did well although her aphasia increased and her hemianopsia remained as complete. She went home on February 9, 1926. On February 15, she complained of stiffness in her right arm and leg, and her aphasia was increasing. She returned to the hospital on March 11, and upon five successive days received deep X-ray therapy over the area of the decompression and osteoplastic flap.

Following this, the decompression area began to herniate and by March 19 had assumed enormous proportions. I then reelevated the bone flap and found that the tumor mass occupied the entire field. I removed about eighty grams of tumor tissue and replaced the flap without the bone. The patient's speech then became better and she became able to walk, although with a marked hemiplegic gait. She returned home on March 31, 1926. Her subsequent course from this time until May 17 was irregular, but on the whole she was comfortable and her condition did not become worse. On May 17 she suddenly developed a tremendous and acute increase in intracranial pressure and was returned to the hospital. The intravenous administration of hypertonic glucose solution gave immediate relief. Examination at this time revealed a tumor mass about the size of an English walnut over the posterior aspect of the right arm. This was firm, circumscribed and not painful. The aphasia and hemiplegia were unchanged. The herniation through the decompression area was quite large and was evidently a tumor mass. The patient again returned home on May 23.

On June 2, she returned to the hospital. She was then obviously failing rapidly. Hypertonic solutions were without effect. The mass over her right arm had grown to the size of a small orange, but was still circumscribed. The skin over it was not movable and was quite red. A small marble-sized tumor was found in the left axilla. On



FIG. 4.—Tumor mass removed from soft tissue of right arm. Hematoxylin-eosin stain x 80.

June 15, a small mass exactly similar to those described was found over the eleventh rib anteriorly. It seemed to lie just beneath the skin. On June 18, a nodule was found in the substance of the right pectoral muscle. Exitus occurred July 20, 1926.

*Necropsy.*—There was a firm, movable, dark purplish mass in the soft tissues of the posterior surface of the right arm which measured 7 cm. in diameter. Another small firm nodular mass 1 cm. in diameter was present over the right scapula, and another 1.5 cm. in diameter at the left lower costal margin.

On the lateral surface of the lower lobe of the left lung were two small firm nodules measuring from 2 to 5 mm. in diameter. Another nodule 1.5 cm. in diameter was present

in the centre of the upper lobe of the left lung. On section these nodules were flesh-like and slightly gray. No masses were found in the right lung.

Upon fixation and removal, the brain showed a tumor mass which projected from the lateral surface of the left cerebral hemisphere. This was spheroidal and measured 15 cm. in diameter. It was composed of lobulated masses with numerous cystic and degenerated areas (Fig. 1). The opposite hemisphere was symmetrically shaped and showed no tumor masses.

*Microscopic Anatomy.*—

A microscopic section of the neoplasm in the brain is made up chiefly of large glial cells which resemble the pyriform cells described by

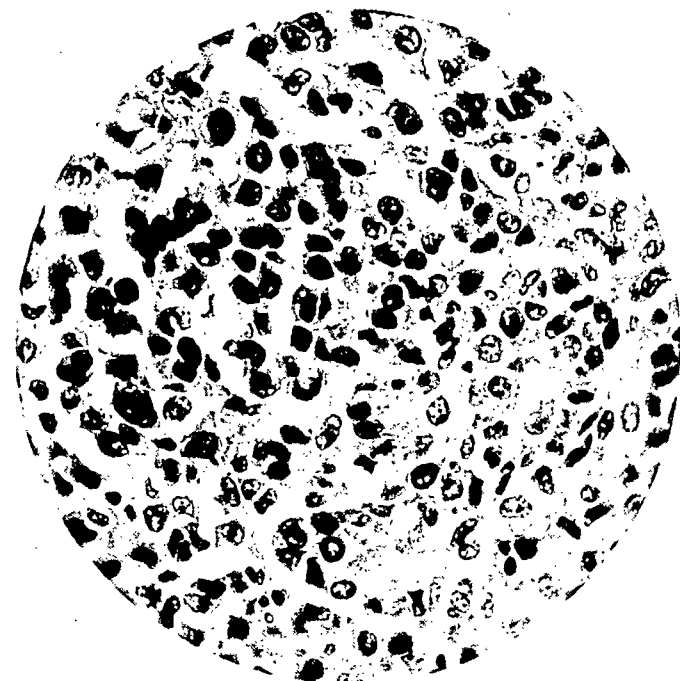


FIG. 5.—Section of tumor mass taken from soft tissues of right arm shows multinucleated cells similar to those found in the neoplasm of the brain. Hematoxylin-eosin stain  $\times 380$ .

Globus and Strauss in cases of spongioblastoma multiforme. Many giant cells are present. The nuclei have bizarre shapes and seem to be dividing directly. No mitotic figures are present, although the unusual shapes of the nuclei give the appearance of mitosis. The cytoplasm is voluminous and stains opaquely. The lumen of many of the blood-vessels in the tumor tissue is closed by a proliferation of endothelial cells. The neoplasm appears to invade these hypertrophied vessels, but tumor cells are not found within the lumen of the vessels. There is a tendency for the cells to form a pseudo-palisade about the vessels. No nerve cells are found, and there is no tendency for the cells to develop into astrocytes.

The cells of the growths in the lung and in the soft tissues of the arm and back are similar in all respects to those found in the cerebral neoplasm. In these instances, however, the cells infiltrate fibrous connective tissue. Moreover there is no endothelial proliferation in the vessels such as is seen in the brain tumor. The similarity of the microscopic picture leaves little doubt that these tumors are metastases from the spongioblastoma multiforme of the brain (Figs. 2, 3, 4, 5, 6).

Dr. Wilder Penfield, of New York City, was kind enough to examine sections of the brain tumor and the metastases. His diagnosis was spongioblastoma multiforme. He adds, "There is one thing which is absent in this tumor which is found in most spongioblastomas, that is, the numerous small nuclei in cells with a scanty cytoplasm which I

have always considered to represent the spongioblast. In one or two areas of this tumor there are collections of these smaller cells but they are nearly altogether absent. Multiplication has taken place along the pyriform and giant cells."

*Comment.*—The tumors classified as spongioblastoma multiforme are the most common of the cerebral neoplasms. The unusual point of clinical interest in this instance is the occurrence of metastases at a distance in tissues embryologically distinct from the nervous system. Such metastases are so uncommon as to make them a rarity. The opposite process of metastasis from other viscera to the brain is not infrequent and has been well described by Grant,<sup>5</sup> Hassin<sup>6</sup> and many others.

In their excellent article upon the spongioblastoma multiforme, Globus and Strauss record no instance of metastases and attribute this fact to the limited migratory tendency of the spongioblast due to its special morphology. Spongioblastomas invade the surrounding cerebral tissue diffusely and produce degenerative changes in the neighboring normal brain cells.



FIG. 6.—Section of tumor mass found in the lung which shows characteristic cells of spongioblastoma multiforme. Hematoxylin-eosin x 60.

It is this constant process of destruction and repair which, in the opinion of Cushing and Bailey, produces the multiformity of their structure.

In Cushing's large series of verified intracranial tumors the spongioblastomas represented about one-third of all the classified gliomas. Because of their tendency to recur, even after the most extensive attempts at surgical removal, they have no doubt been the cause of the discouraging impression prevalent with regard to gliomas as a group. The clinical course of the case here reported furnished a typical example of their outstanding characteristics. At the first operation it was thought that an apparently enucleable mass had been removed. The photograph of the autopsy section shows how extensive and wholly undemarcated from normal brain tissue the tumor was at that time. The rapid growth and extension in spite of intensive deep X-ray therapy adds another discouraging chapter to the story. At present, at least, it appears that surgical treatment of these tumors can serve only to prolong life, save vision and alleviate pain. It should not be forgotten that the

spongioblastomas of the brain do not stand alone in this respect among malignant tumors.

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# THE RÔLE OF THE DURA MATER IN CRANIAL DECOMPRESSIVE OPERATIONS

A NOTE ON THE PRESERVATION OF THE INNER LAYER OF THE DURA IN CRANIAL DECOMPRESSIVE OPERATIONS, AND ON THE USE OF THE OUTER DURAL LAYER FOR THE PLASTIC CLOSURE OF DURAL DEFECTS

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THE cranial dura mater consists of an external or parietal and an internal or visceral layer. These are adherent to each other to form one membrane, excepting in the locations where the two layers are separated to enclose the venous sinuses, the pituitary body, and the Gas-serian ganglion.

The outer or parietal layer of the dura is relatively thick, consists of fibrous with some elastic tissue, serves as the periosteum of the inner surface of the bones which form the cranial cavity, and in it or on its surface run the meningeal vessels. The inner or visceral layer is relatively thin, is composed mostly of elastic fibres, and is united to the outer layer by fine strands of connective tissue.

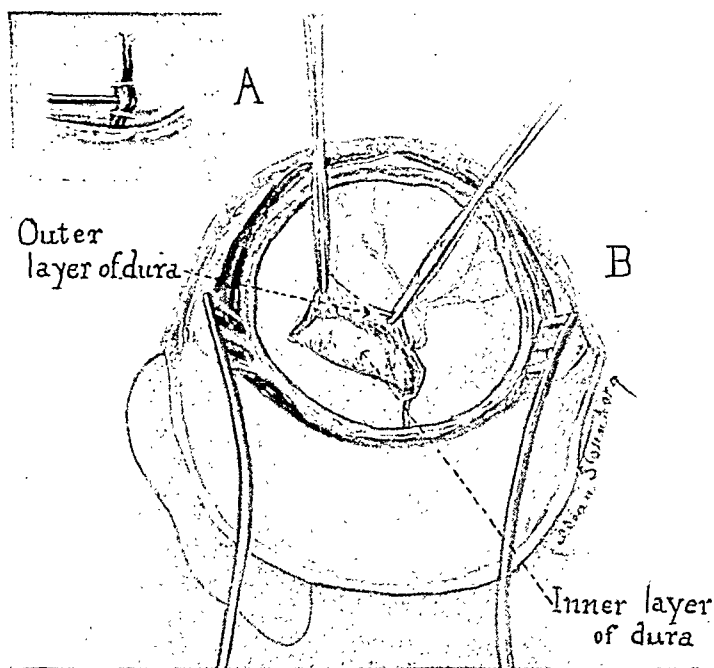


FIG. 1.—The first stages in the separation of the outer from the inner layer of the dura. A. Two clips supplied to the meningeal artery after the outer dural layer has been incised and the vessel with the outer layer raised up by means of a grooved director. B. The meningeal artery has been divided and the separation of outer from inner layer of dura has been begun.

If, at the operating table, the proper cleavage plane between the two lamellæ has been found, and the branches of the meningeal vessels which cross the field have been ligated, the external can be stripped or peeled off from the internal layer without special difficulty and without bleeding.

The blood supply of the inner is derived from the vessels in the outer layer, and after the latter has been separated from the former, incision of the inner layer is bloodless—unless a cortical tumor is adherent to the dura or unless as the result of trauma or an inflammatory disease there are vascular adhesions between the leptomeninges or cerebral cortex and the inner surface of the dura.

The inner layer of the dura is thin and yielding, and if there is an increase

of intracranial pressure, the brain covered only by this internal lamella will bulge through a defect made in the outer layer.

A recognition of the facts above enumerated has led us, in a number of

instances, to preserve the inner layer of the dura in some of our decompressive operations, and to use the outer layer of that membrane for the plastic closure of dural defects.

The improvements in the methods for the localization, the approach to, and the removal of intracranial tumors have reduced the number of cases in which a subtemporal decompression is necessary. The operation must still be done, how-

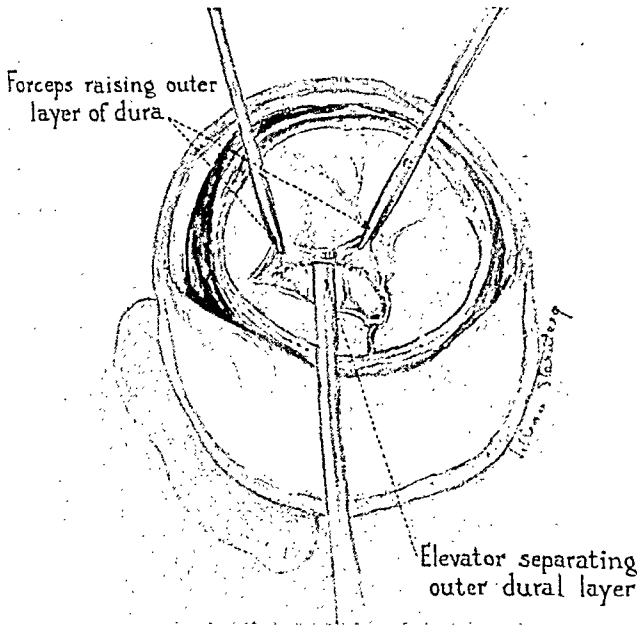


FIG. 2.—The blunt elevator separating the outer from the inner layer of the dura.

ever, at base of a bone flap where a neoplasm is irremovable, or as a temporizing procedure in unlocalized growths and in some patients with increased intracranial pressure after cranial trauma.

As originally proposed by Cushing, the typical decompressive operation for supratentorial expanding lesions is performed in the right temporal region where the resultant brain hernia is covered and supported by the temporal muscle, and the dura has always been incised or excised so that the brain can protrude through the defect made in the membrane.

In states of increased intracranial pressure, a perfectly satisfactory decompression can be obtained if only the outer dural layer is excised, and unless there were special indications for subdural exploration or drainage, we have in a number of instances performed a subtemporal decompression

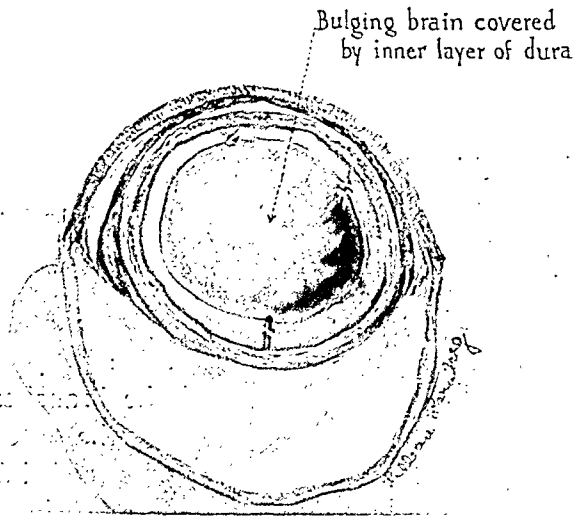


FIG. 3.—Subtemporal decompression with preservation of the inner layer of the dura. The outer layer has been excised and the brain covered by the inner layer is beginning to herniate.

with preservation of the inner layer of the dura. By this modification of the usual technic, the injury to the cortex which may occur from the violent protrusion of the brain as soon as the dura has been incised, and the later formation of adhesions between the cortex and the overlying muscle is prevented. The herniation of brain covered by a thin layer of dura occurs more gradually, but at the expiration of a few weeks the bulging is no different from that which occurs when the entire dura is divided.

Technically, the following details require mention. After the bone defect has been made, the outer layer of the dura in the lowermost part of the exposed area is incised along the course of the middle meningeal artery or one of its branches. By means of a grooved director the outer layer of the dura with the vessel is raised up and the artery divided after silver clips or ligatures have been applied (Fig.

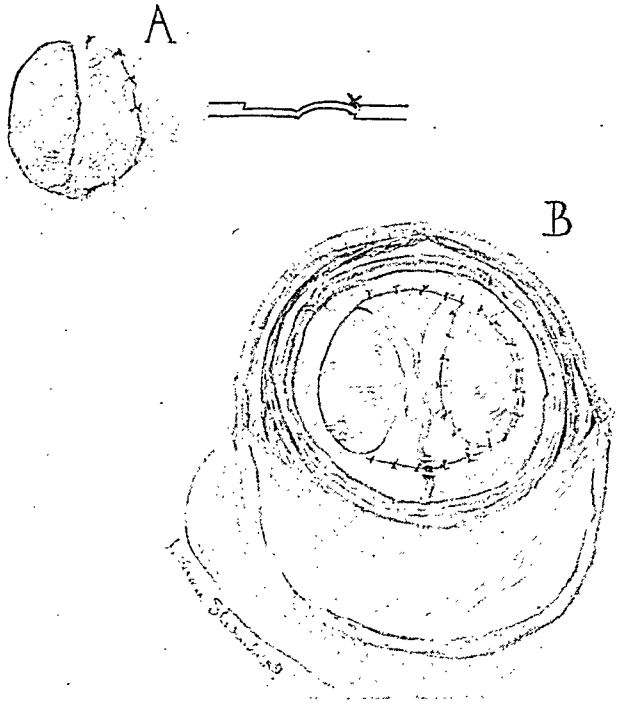


FIG. 4.—A. Plastic closure of a defect in the dura by means of a flap from the outer layer. B. Closure of a dural defect by a free transplant from the outer layer. (Somewhat diagrammatic.)

1). A smooth periosteal elevator or a blunt dissector is then passed under the outer layer which has been grasped and raised up with mosquito forceps and this layer gradually detached by slowly sweeping the instrument from side to side (Fig. 2). In order that the line of separation may be visible, the incision in the outer layer is progressively enlarged until the dissection has been carried out to the edges of the bone defect. The outer layer is then excised about one-half to one centimetre from the margins of the bone, any small bleeding vessels being ligated or caught with silver clips (Fig. 3). The suture of the muscle, fascia and subcutaneous tissues follows: If the subcuticular stitches are carefully inserted, a skin suture is unnecessary. The inner layer of the dura is usually so thin and transparent, that the cortex is visible through it. Some care must be taken in the separation of the two layers and occasionally a small rent has been made in the inner layer. This is of no especial significance. In some instances, the outer layer of the dura can be separated into two lamellæ so that the operator might be raising only part of the external layer of the dura in the belief that the entire layer was being elevated. The best guide is the dura in the region of the meningeal artery. If the proper cleavage plane has been found, a fairly thick layer of dura should be raised with the vessel.



PLASTIC CLOSURE OF DEFECTS IN THE DURA BY MEANS OF FLAPS OR  
TRANSPLANTS OF THE OUTER LAYER

In a number of instances in which, due either to increased intracranial pressure or to the fact that an area of dura had been excised with a cortical growth, the cut edges of the dura could not be approximated, we have closed the defect by means of a flap of the outer layer of the dura which was raised and turned down so that its external surface lay against the cortex, and the edges of the flap were sutured to the free margins of the

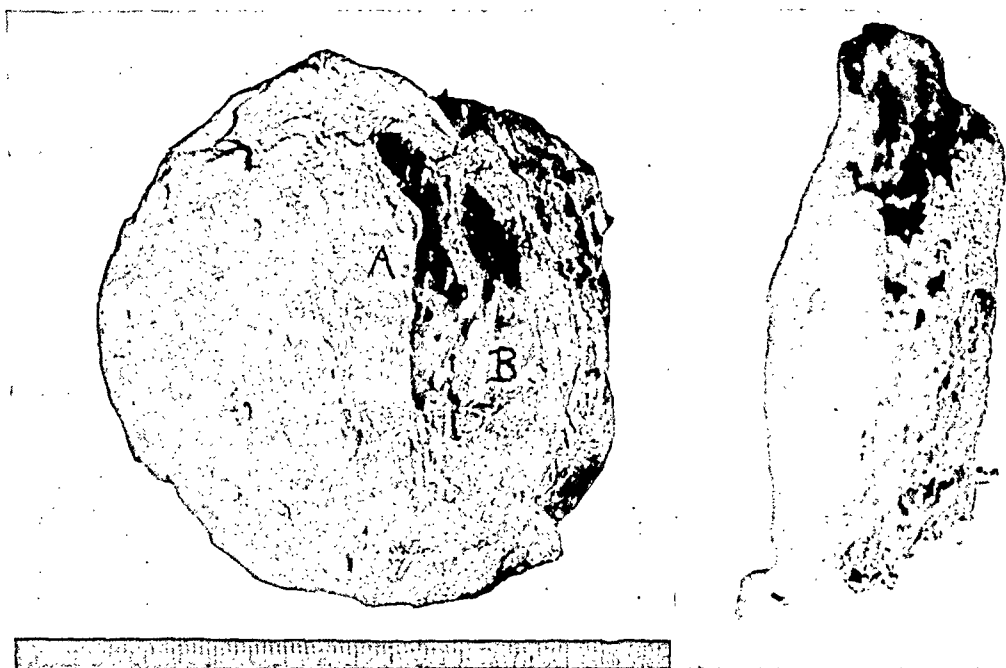


FIG. 5.—An extradural meningioma removed with only the outer layer of the dura. A. External layer of dura. B. Capsule of tumor.

dural incision. By this means, a defect three to four centimetres in size in both diameters can be closed by this little operation on the dura (Fig. 4A). After we had performed this plastic operation on the dura in a number of patients, I found, in the study of the literature, that Brüning (*Deutsche Zeitschrift für Chirurgie*, vol. cxiii, pp. 413-417) had proposed the same procedure in 1912, and had used it with satisfactory results in three cranial operations.

We have, in several patients excised a piece of the outer layer of the dura and transplanted it into a defect at some distance away (Fig. 4B).

Finally, it is feasible in some operations for meningeal tumor only slightly adherent to the dura, to excise only the inner layer of that membrane with the growth. Such a procedure will, however, be only rarely permissible on account of the danger that the outer layer of the dura may contain tumor cells. In one instance of extradural tumor—a flat meningioma (Fig. 5)—only the outer layer of the dura was removed with the neoplasm.

# ACQUIRED ARTERIOVENOUS FISTULA\*

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ARTERIOVENOUS fistula, strictly speaking, applies to a direct communication between an arterial and a venous channel. This would therefore be the aneurismal varix of former classifications. When there is an intervening false aneurismal sac between an artery and vein the term varicose aneurism has been applied. The less common varieties, venous encysted varicose aneurism, arterial encysted varicose aneurism, double arterial and venous encysted varicose aneurism, double arterial or venous intermediate encysted varicose aneurism, arteriovenous aneurism, and so forth, are all interesting academically, but the essential and practical feature of them all is the communication between the arterial and venous channel.

To William Hunter (1757) properly belongs the credit of first describing accurately the clinical features and the local and regional vascular physiologic disturbances of arteriovenous fistula. He observed two cases in which the condition developed in the arm by venupuncture with accidental piercing of the artery in addition to the vein. Morvan (1847) attributed to Boisseau the first intimation that a cardiac affection may complicate arteriovenous aneurism. Branham (1890) first described the important sign which has been given his name. It is mainly to contemporaneous investigators (first among whom are Halsted, Matas, Makins, Holman, Hoover and Beams, Reid, Lewis and Drury), however, that we owe most of our knowledge of the systemic or cardiovascular effects of the condition. These observers, even with their modern methods and instruments of study, are not in accord. A brief discussion of the two main theories of the pathologic physiology of the systemic effects will be given here.

## CALLANDER'S ANALYSIS OF THE CAUSES OF ARTERIOVENOUS FISTULA

189 projectiles	28 contusions
166 bullets	5 fractures
2 bombs	20 secondary aneurisms
5 shrapnels	7 doubtful origin
9 shell	3 congenital
6 pieces of metal	34 unknown
1 grenade	
161 knife wounds	447 total
38 venesections	
123 cuts and stabs	

Callander (1920), at Halsted's suggestion, analyzed 447 cases of arterio-

\* Work done under the direction of Dr. J. de J. Pemberton and Dr. G. E. Brown, Divisions of Surgery and Medicine, Mayo Clinic.

venous fistula, including all cases recorded in the literature to 1914, all cases recorded in the surgical histories of Johns Hopkins Hospital, and a number of reports of selected cases appearing in the surgical literature of the World War. Callander's table, quoted on p. 19, shows the predominating cause of arteriovenous fistula to be some form of traumatism, and rarely congenital.

Saint, of the Mayo Foundation (1926), reported three cases of congenital arteriovenous fistula. In these cases the extremity affected had been abnormal since birth, either excessively hot or enlarged, and in all Pemberton found it necessary to amputate the distal part of the extremity because of extensive ulceration or gangrene which would not heal. Congenital arteriovenous fistula is a developmental anomaly in which there are always multiple fistulas between the arteries and veins as opposed to the single communication usually found in traumatic cases. This multiplicity of fistulas makes surgical treatment very unsatisfactory.

Four cases of acquired arteriovenous fistula, all of which were in the process of examination and treatment at the same time, are reported in this paper. One was due to a gunshot wound and three to contusions. The first case illustrates some of the cardiovascular effects. The other three were accompanied by local and regional changes only. Operation was performed in all the cases.

CASE I.—*Fistula Between the Axillary Artery and Vein*.—A man, aged twenty-one, a postal clerk, while attempting to make new alignments of the sights of an "unloaded" 0.22-calibre repeating rifle which had been placed in a vise at an upward angle of 45 degrees, was accidentally shot in the left side of the chest from a distance of about 3 feet. The bullet entered the third left intercostal space medial to the anterior axillary line. Later a röntgenogram showed it in the region of the left acromion process. External hemorrhage was severe, and a large swelling appeared beneath the left pectoral muscles; there was also subcutaneous emphysema between the puncture wound and the left clavicle. The left arm was completely paralyzed at first. Proper emergency treatment was instituted and the patient recovered from the immediate effects of the injury. About two months later (October, 1926) a pulsating swelling below the left clavicle was discovered by a physician and aneurism diagnosed.

On the patient's admission to the Mayo Clinic three months after the accident he complained of inability to use the left wrist and hand, of dull aching pain in the hand and sometimes in the shoulder, and of numbness and sometimes tingling in the back of the hand, inner side of the forearm and in the fourth and fifth fingers. The entire left upper extremity above the wrist was larger than the right, with flattening of the deltoid region. There were no enlarged veins. The back of the hand was markedly oedematous and the hand and fingers were of a reddish cyanotic hue and felt cold. There was limitation of shoulder and elbow movements by about 40 per cent., some limitation of pronation and supination, wrist-drop with inability to flex or extend the fingers and anaesthesia in the distribution of the cutaneous branches of the radial and ulnar nerves; in short, evidence of injury of the medial and posterior cords of the brachial plexus. Just below the outer half of the left clavicle was a pulsating fulness over which was a continuous thrill within a circle with a radius of about 4 cm. A loud hum with systolic accentuation was heard over the upper anterior and posterior portions of the wall of the chest, loudest over the area of the thrill and conducted down the inner side of the left arm as far as the elbow. The pulses were equal and synchronous and of the

## ACQUIRED ARTERIOVENOUS FISTULA

water-hammer type. Systolic blood-pressure in the right arm was 130; the diastolic seemed to be about 60, although the sounds were heard down to zero. On account of the bruit, it was necessary to use the palpatory method on the left arm, and the systolic pressure was found to be between 50 and 60. In the femoral vessels the pressure was about 170 systolic and 100 diastolic. The average pulse rate was 85. Digital compression of the subclavian artery behind the upper border of the inner half of the clavicle eliminated the pulsation, thrill and bruit, as did pressure over the point of maximal intensity of the thrill. The pulse rate during this manoeuvre immediately dropped 12 beats a minute, from 87 to 75 (Branham's bradycardiac sign). The systolic blood-pressure taken in the right arm did not change appreciably, but the diastolic became definite at about 78. Subcutaneous injection of  $1/30$  of a grain of atropine sulphate caused the pulse rate to increase in twenty-five minutes to 124. Occlusion of the left subclavian then caused a drop of only 9 beats a minute. In either case immediately after release of compression the pulse rate resumed its original and more rapid rate. Capillary pulsation was not noted. The blood flow in the left arm was not great enough to be measured with the Stewart apparatus available. The skin temperature of the two upper extremities was practically the same, although after the patient entered the hospital from the cold outside air the left hand was distinctly colder than the right. The heart was 12.5 cm. in transverse diameter and there were no murmurs. The electrocardiogram did not show significant changes. Blood drawn from veins in the antecubital region had an oxygen saturation of 67 per cent. on the right and 81 per cent. on the left, indicating that the blood in the veins of the left arm was half arterial and half venous.† The blood volume as determined by the Congo-red method and with specimens from both arms gave an average reading of 89 c.c. for each kilogram of body weight. The hematocrit ratio and the blood counts were within normal limits. The Wassermann reaction on the blood was negative. A diagnosis was made of a small arteriovenous fistula of the third portion of the left subclavian artery and vein or of the first portion of the axillary and injury of the brachial plexus.

December 15, Pemberton operated through an anterior incision and found that the communication was between the axillary vessels under the pectoralis minor, which he divided (Fig. 1). The cephalic vein was greatly dilated and the axillary artery proximal to the fistula was slightly enlarged. The axillary vein was in a mass of scar tissue and owing to the fact that a nerve, evidently the medial cord of the brachial plexus, entered this same mass, he did not try to dissect the vein free below. He ligated the artery above and below the fistula and the vein above with heavy silk.

Recovery was uneventful. Surgical repair of the brachial plexus was deferred. After operation the left hand was warm and more nearly normal in color. On the tenth day the blood-pressure in the right arm was about 120 systolic and 68 diastolic and the sound was no longer heard below the normal fourth phase. The femoral pressure was about 160 systolic and 100 diastolic. A small pulse was perceptible in the region of the left radial artery. The pulse in the right radial did not seem to be of the water-hammer type. The average pulse rate was 80 a minute. The cardiac shadow on the seventeenth day after operation was 12 cm. in transverse diameter. The blood volume had not changed.

The patient returned June 10, 1927, for repair of the left brachial plexus. Pain in the left arm had ceased. There was some improvement neurologically, although the function of the nerve trunks was still impaired, the ulnar nerve being most involved. The hand had the appearance of median nerve change. There was greater amplitude of rotation at the shoulder-joint. The œdema of the hand was somewhat reduced. The fistula recurred. There was a slight thrill and pulsation over the site of the fistula and a marked hum over the upper left side of the chest and down the inner side of the left

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† This test was suggested by Dr. George E. Brown.

arm to the elbow. The blood-pressure in the right arm was 136 systolic and 76 diastolic, and in the left by the palpatory method the systolic pressure was about 50. The pulse rate was 88. There were no other changes in the cardiovascular system. June 15, Adson exposed the fistula and the left brachial plexus. Bleeding was profuse. The subclavian artery above and the axillary artery below were pulsating into a mass at the site of the fistula, and the subclavian, brachial and cephalic veins were also pulsating into this mass. In an attempt to dissect the brachial plexus the aneurism was opened from below. The brachial plexus was then traced down from above and the aneurism

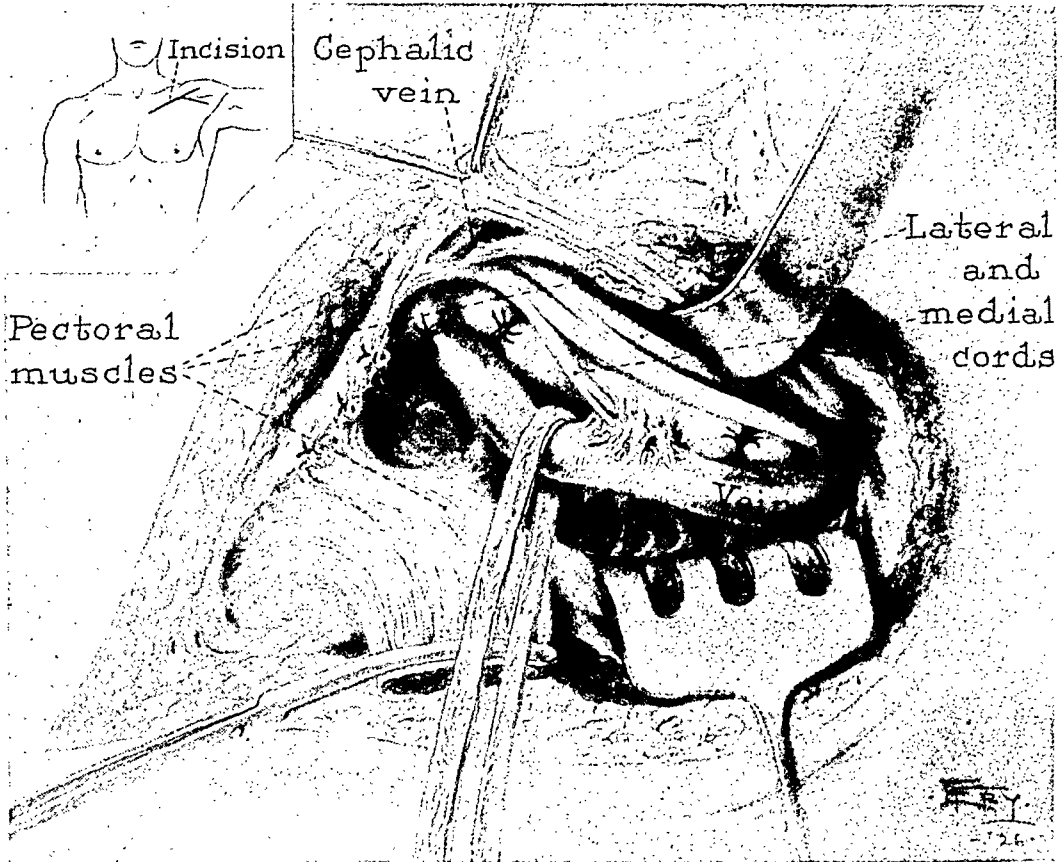


FIG. 1.—(Case I.) Axillary artery and vein, site of fistula, and the relationship of the brachial plexus to the fistula, as noted at the first operation. The vein distal to the fistula was embedded in a mass of scar tissue and could not be isolated without further injury to the nerves. The points of ligation are indicated. Insert shows the incision of approach.

opened again. It was necessary then to ligate the subclavian artery and vein, the upper end of the brachial artery just above the profunda, and the cephalic and brachial veins and to resect the whole aneurismal mass. The dissection of the brachial plexus was continued, and the inner head of the median nerve, the ulnar nerve and the radial nerve were found to have been severed. An end-to-end anastomosis of these nerves was made after resection of the neuroma. The following day the collateral arteries and veins leading into the old aneurism were ligated. Convalescence was stormy and complicated by infection of the wound. Up to the time of dismissal from observation, July 13, no definite improvement in the neurologic condition was noted.

*Comment.*—This patient manifested the bradycardiac reaction, the increased heart rate, the increased pulse pressure, the arm-leg differential pressure, and questionable enlargement of the heart. Although the fistula was small, it might in time have caused serious cardiac embarrassment. This case

brings up the question of the necessity of testing the efficiency of the collateral circulation. Matas<sup>9</sup> advises testing of the collateral circulation before the ligation of the main source of blood supply to a limb, and if this does not seem sufficient, to "train the collaterals" by periods of compression of the vessels to be ligated. Reid has demonstrated that this procedure is not necessary and has called attention to the fact that the fistula is itself a greater stimulus to the formation of collaterals than is the tying off of the main artery. If the vessels cannot be restored, however, by some form of endo-aneurismorrhaphy,<sup>10</sup> the best procedure is to ligate both artery and vein above and below, since single or double ligation of the artery alone may lead to gangrene of the limb due to the rapid drainage of the blood supply from the collateral arteries through the large vein as well as through the collateral veins. The balance between inflow and outflow is maintained by ligating both artery and vein. Recurrence in this case was probably due to inability to ligate the vein below the fistula, and it was necessary at the second operation to excise the fistula in its entirety.

**CASE II.—Pulsating Exophthalmos Believed to be a Fistula Between the Internal Carotid Artery and the Cavernous Sinus.**—A man, aged forty-eight, was in an automobile accident October 21, 1926, and was picked up unconscious. He regained full consciousness in seven hours. The scalp was lacerated in the right parietal region but there were no other injuries.

Simple concussion of the brain was diagnosed. Since the accident he had experienced a "swishing" noise in the left ear synchronous with the heart beat and on the third day diplopia appeared with intermittent frontal headache which was worse after he had assumed the reclining position. Both eyes were bloodshot and the eyelids swollen; they became normal in two weeks, but soon afterward the left conjunctiva became congested and the eyeball began to protrude.

On examination at the Mayo Clinic, December 6, there was moderate proptosis of the left eye with moderate œdema of the lids and marked conjunctival congestion and chemosis, lacrimation and epiphora. The exophthalmometer registered 25 mm. on the left and 18 mm. on the right. The left pupil was slightly larger than the right, but both reacted normally to light. There was complete paralysis of the left external rectus and some limitation of movement of the orbit in all directions. Vision was normal. Slight pressure on the eyeball elicited a faint pulsation synchronous with the heart beat. The veins of the left retina examined with the ophthalmoscope were considerably engorged. A continuous loud hum with systolic accentuation was heard over the entire cranium



FIG. 2.—(Case II.) Patient just prior to operation with well marked exophthalmos and paralysis of the external ocular muscle of the left eye.

and both eyeballs, but was most intense over the left eyeball. Occlusion of the left carotid by pressure caused the pulsation, hum, and subjective swishing to disappear, but did not definitely alter the pulse rate. The average pulse rate was 72. The systolic blood-pressure was 116 and the diastolic 76. The heart was not enlarged. A röntgenogram of the skull was negative. A diagnosis was made of arteriovenous fistula between the left internal carotid and the cavernous sinus with pulsating exophthalmos (Fig. 2).

December 16, Pemberton ligated the left internal carotid artery in the neck. The pulsation, hum, and swishing disappeared, but a soft continuous humming sound continued in the right ear. On the fifteenth day after operation the proptosis was much reduced, the exophthalmometer reading 21 mm., the conjunctival congestion and chemosis had disappeared, and the retinal veins were nearly normal in size. The ocular palsies were about the same as before (Fig. 3). Five months after operation the patient reported that he had had no headaches and no subjective sound in the ear. He still had some strabismus and suffered occasional momentary attacks of double vision.



FIG. 3.—(Case II.) Two weeks after operation, exophthalmos greatly reduced and the ocular palsy remaining.

*Comment.*—In an extensive review of the literature from 1809 to June, 1923, Locke found 588 cases of pulsating exophthalmos. The etiology was noted in 544 cases. Twenty-three per cent. were spontaneous and 77 per cent. were traumatic. In the spontaneous cases females predominated (74 per cent.). The average age in cases of the spontaneous type was near the end of the fifth decade, and in the traumatic cases near the end of the third decade. Necropsy was performed in fifty cases, thirty-three in spontaneous cases and seven-

teen in traumatic. Of the thirty-three spontaneous cases no lesion was found in four; probable communication between the carotid artery and the cavernous sinus was found in sixteen; orbital tumor was found in seven, and aneurism of the ophthalmic artery in three. In sixteen of the seventeen cases of traumatic pulsating exophthalmos there was a communication between the carotid artery and the cavernous sinus, and in one there was an aneurism of the carotid. There is a close anatomic relation of the sphenoid bone, cavernous sinus, internal carotid artery, the second, third, fourth and sixth nerves, and the ophthalmic and maxillary divisions of the fifth nerve. In explaining the relative frequency of this lesion after severe head injuries Locke quotes Rawlings as stating that the sphenoid bone was

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involved in 70 per cent. of all fractures of the base of the skull. Locke, reviewing the result of treatment, found the following:

	Cases	Cured or improved, per cent.	Mortality per cent.
Compression of carotid .....	106	26	..
Ligation of common carotid .....	234	65	9
Ligation of internal carotid .....	38	88	8
Bilateral ligation of carotid .....	21	62	14
Ligation of orbital veins .....	19	68	5
Ligation of orbital veins and ligation of carotid .....	24	71	17
Rest and medication .....	28	50	4
Gelatin injections (subcutaneous) .....	16	63	..

It is difficult to explain why ligation of the internal carotid cures in so many cases. It may be that the slowing of the blood stream through the fistula incident to the ligation of the carotid artery is more marked than normal because of the obstruction to blood flow offered by the trabeculations in the cavernous sinus, permitting clotting in the fistulous tract to take place before the secondary rise of blood-pressure in the carotid after the complete reestablishment of the collateral circulation. It is not necessary to institute a course of digital compression preliminary to ligation of the carotid artery in cases of true arteriovenous communication, as has been advised, since the fistula itself serves as a stimulus to collateral circulation. The fistula rarely produces systemic disturbances but may seriously affect the eye.

CASE III.—*Fistula Between the Temporal Artery and a Vein of the Scalp.*—A Russian-Canadian farmer, aged thirty-eight, came to the Mayo Clinic complaining of a chronic cough. Nine years previous to admission a limb of a tree about 5 cm. in diameter and several feet long struck him on the top of the head as the tree fell. A tender, firm, blackish lump formed in the left parietal region, but he continued to work. The lids of the left eye were swollen and black. The lump gradually disappeared, leaving a soft swelling in the left parietal region. Enlarged veins down the front of the forehead had appeared only within the last three years. He felt a throbbing at times in the head, and if he wore a tight cap he heard a humming sound in both ears.

December, 1926, examination of the shaved scalp showed several large and tortuous veins diverging from a large, pouchy, fluctuating swelling, 3 by 4 by 1 cm., in the left parietal region (Fig. 4). The left temporal artery was enlarged, thick, and tortuous and entered this main swelling, in which it could be palpated. The left occipital artery was also enlarged and travelled upward toward the swelling. The parietal branch of the right temporal artery could be palpated as it passed over the vertex to the region of the swelling. Over the point of greatest swelling could be felt a marked thrill, and a loud continuous bruit with systolic accentuation was heard on auscultation over the swelling. The latter was transmitted down the left temporal artery as far as the zygoma, part way down the left occipital artery, and was present to a lesser degree over the vertex of the skull. Pressure at the point of maximal thrill caused a cessation of the bruit and thrill and collapse of the veins. When the left temporal artery was occluded the thrill and bruit were greatly reduced, and the pulsation in the temporal artery in the swelling was decreased. If both temporal arteries were occluded there was still greater diminution in these signs; if the left occipital was also compressed the effect was practically the abolishment of the signs, and if the right occipital artery was also shut off the signs disappeared entirely. Blood drawn from the venous swelling



near the thrill had an oxygen content of 94 per cent. It was, therefore, arterial blood. In the course of the main swelling there was a depression in the skull which resembled a groove. A röntgenogram of the skull, however, was negative. Examination of the general cardiovascular system revealed nothing of significance. A diagnosis was

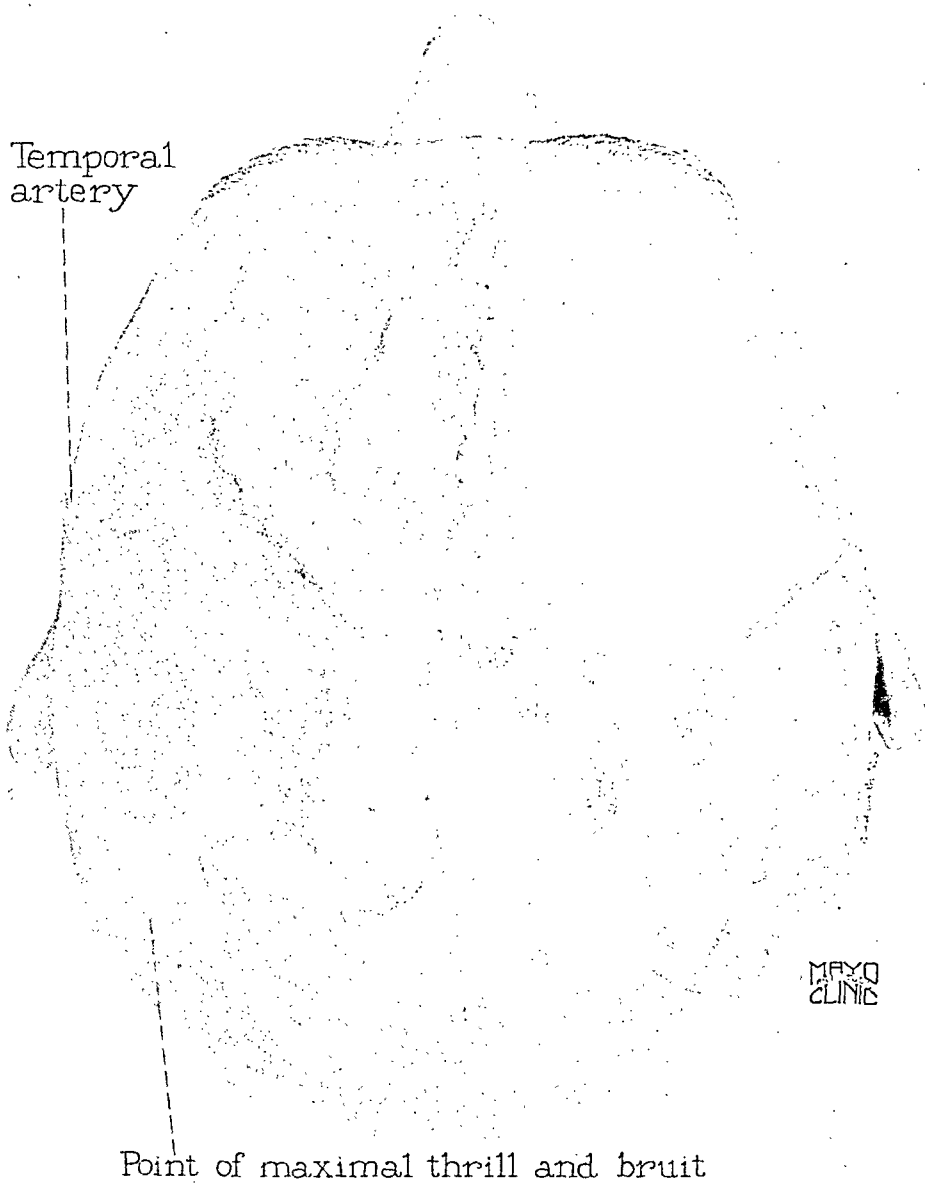


FIG. 4.—(Case III.) Shaved scalp viewed from above and showing the cirroid aneurism. Site of anastomosis is indicated.

made of arteriovenous fistula between the parietal branch of the left temporal artery and one of the veins of the scalp; the right temporal artery and both occipitals anastomosed with branches of this artery and in this way helped to feed the fistula. There had been no effect on the general circulatory system after nine years, and it was therefore decided to extirpate the fistula for local reasons only.

December 31, Pemberton ligated both superficial temporal arteries and the right occipital artery, placed a circle of hemostatic sutures in the scalp around the fistula,

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made a curved scalp flap and excised a large segment of the vessels. The skin over the vessels was very thin, due apparently to fat atrophy; this had given the sensation of a depression in the scalp on palpation. Dissection of the removed vessels revealed a small fistula with thickened walls between the artery and vein. The vein was greatly dilated, and the artery generally hypertrophied. Convalescence was uneventful.

**CASE IV.—*Fistula Between the Artery and Vein of the Superficial Palmar Arch.***—A man, aged thirty-two, had injured his right hand thirteen years before while playing baseball. A firm swelling appeared suddenly in the palm after an impact with the ball. The swelling gradually declined, leaving a soft, fluctuating, bluish lump at the base of the middle finger, extending part way up the sides of the finger. Five years later he noticed a scaly, tender area below the tip of the middle finger. This spread a little during the next year. He then consulted a physician who made a röntgenogram and told the patient that the bones of the finger were dead from lack of nourishment. The finger was amputated at the metacarpophalangeal joint; the flaps healed quickly. A year before examination he noticed a scaly area on the dorsal region of the stump similar to the one which had been on the tip of the finger. At one time a little fluid collected and ruptured through the skin, but healing occurred after a few days of drainage. The swelling at the base of the amputated finger had not increased in size in the thirteen years of its existence.

On examination in December, 1926, it was observed that the veins of the right forearm and back of the hand were more prominent and more numerous than normal. At the distal end of the third metacarpal bone over the site of amputation and mainly on the palmar surface



FIG. 5.—(Case IV.) Palmar aspect of the right hand, showing the swelling just proximal to the stump of the amputated finger and the enlarged veins above the wrist.

was a fluctuating bluish mass about 2.5 cm. in diameter, which was felt to pulsate faintly synchronous with the pulse (Fig. 5). The palm of the right hand was moist and warm; the backs of the fingers were bluish and the palm was somewhat pallid. On the dorsal surface of the swelling was a purplish scaly area. If the hand was tightly clenched and then opened there was delay of the return of color in the palm. No thrill could be palpated. A moderately loud hum with systolic accentuation was audible on auscultation in the proximal half of the palm and over the back of the hand, especially between the metacarpal bones, and was conducted up the course of the radial artery half way to the region of the elbow and a short way up the course of the ulnar artery. It was loudest over the hypothenar eminence. Occlusion of the radial artery had little effect on the sound; occlusion of the ulnar stopped it. Blood drawn from a large vein of the right forearm showed an oxygen content of 94 per cent. indicating the blood of the vein to be arterial. A röntgenogram of the right hand showed slight periarticular arthritis of the phalangeal joints. Examination of the general cardiovascular system revealed nothing abnormal. Arteriovenous aneurism of the superficial palmar arch, possibly with multiple anastomoses, was diagnosed. Surgical interference was indicated for local reasons only.

December 31, Pemberton, hoping that the communication might be a simple one involving only the digital vessels to the amputated finger, exposed the fluctuating swelling through a curved lower palmar incision. The fistula was apparently more proximal, and since in order to extirpate it the circulation of the whole hand would have been jeopardized, only the third and fourth digital branches of the superficial palmar arch and the veins at the stump of the middle finger were ligated. Healing was prolonged, and the same signs were present after operation as before.

*Comment.*—There was some question in this case as to whether there was actually an arteriovenous anastomosis, but this was definitely settled by the determination of the oxygen content and capacity of the blood in the veins from the forearm. This method of diagnosis is simple and positive. The blood is drawn from a vein in the region of the lesion if possible; if it shows an oxygen content well above normal (70 per cent.), it is mixed with arterial blood, a condition which is possible only with an arteriovenous anastomosis.

#### DISCUSSION

The local effects of a fistula consist in dilatation of the distal part of the vein and of the proximal part of the artery. The increased pressure in the vein causes it to expand and hypertrophy and only later brings about incontinence of the valves of the vein; the tributary veins also become dilated. The pressure in the veins is increased and the veins may pulsate. The artery proximal to a large fistula becomes dilated and thin-walled and often shows marked degenerative changes. The surface temperature over the fistula is usually increased, that distal to it decreased. The limb distal to the fistula is often increased in girth due to œdematous infiltration and hypertrophy of the subcutaneous connective tissue with atrophy of the skin and skeletal muscles, and if the anastomosis occurs before the full growth of bone has been attained, there may be an increase in the length of the limb. Trophic changes are prone to occur distal to the fistula. These are due to diminution of the flow of blood through the capillaries owing to its easier path of escape into the veins through the fistula and to the increased pressure in the veins, impeding the return of deoxygenated blood from the capillaries. Anoxemia of the tissues results. If these tissues are even slightly injured the normal inflammatory reaction of repair is feeble or absent, and progressive ulceration or gangrene supervenes. A loud hum with systolic accentuation is heard on auscultation over the fistula and in its neighborhood, and is transmitted down the course of the vein. A thrill is palpable also over the fistula and may be transmitted a short distance along the vein. There is an abnormally high oxygen content of the blood taken from veins near the site of the fistula due to a large admixture of arterial blood. Simple arterial aneurisms rarely cause as marked local or regional disturbance. The murmur is not constant, but when present is systolic in time and therefore intermittent. The thrill if present is less marked. The venous phenomena do not occur and the blood has the normal content of venous blood.

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The relatively large number of cases arising from the World War has stimulated several able surgeons and internists to investigate the systemic effects of arteriovenous fistula. The fact that the World War was more productive of this type of vascular lesion was due to the use of small calibre bullets and shrapnel of high velocity which produced a small orifice and exit for the bullet, a narrow but long curved channel usually crossing the course of the vessels in an oblique direction, and a small perforation in the artery, followed by rapid closure of the wound and primary union of the bullet's track. Matas<sup>11</sup> states that the conditions in the fistula that determine or influence the systemic effects are: (1) the size of the fistula; (2) the volume and force of the arterial stream, short circuited; (3) the calibre of the vessels involved; (4) the proximity of these to the heart; (5) the duration of the fistula; (6) the age of the patient, and (7) the coexistence of antecedent cardiovascular disease. Of these factors the first four are the most important. Fistulas of the iliac, femoral, popliteal, subclavian, axillary, brachial, innominate, and carotid vessels are, of the accessible surgical vessels, most likely to be followed by cardiovascular effects. The systemic changes of the large fistulas are: (1) enlargement of the heart; (2) accelerated heart rate; (3) high pulse pressure, usually due to low diastolic pressure; (4) changes in the pulse and blood-pressure from temporary occlusion of the fistula, especially Branham's bradycardiac sign; (5) the presence of cardiac murmurs, more often systolic at the apex; (6) capillary pulse; (7) high blood-pressure in the leg compared to that in the arm, and (8) increased respiratory rate with dyspnoea on exertion, diminished vital capacity and diminished voluntary control of respiration (holding the breath test).

Branham's bradycardiac sign is said to be pathognomonic of arteriovenous fistula. It consists in immediate and distinct slowing of the heart rate when the fistula is temporarily occluded, either by pressure directly over the leak or by compression of the artery proximal to it. With it both systolic and diastolic pressures are usually raised, the diastolic often more than the systolic, and the cardiac shadow contracts. Besides its diagnostic importance it indicates cardiac efficiency and the ability of the circulation to "tone-up" after extirpation of the fistula. Atropine often abolishes the reaction, showing that it is a vagal effect.

The systemic effects may exist for months or years with adjustment or compensation of the cardiovascular system, but when a break occurs the evidence of cardiac insufficiency and decompensation appear. Even, however, if the liver is enlarged and pulsating, with a systolic centrifugal pulse in the veins, but without signs of pulmonary oedema and cyanosis, extirpation of the fistula may restore the circulation nearly to normal, provided that prior to operation there has been no evidence of ectasis of the right auricle, as shown by absence of flattening of the right subcardial diaphragm, and that the temporary occlusion of the fistula causes elevation of systolic and diastolic blood-pressure.<sup>6</sup>

American investigators <sup>4,6</sup> have concluded from clinical and experimental studies that when a large volume of blood is shunted from the normal system of heart, arteries, capillaries, and veins, into a new system of heart, artery, fistula, and vein there is a great decrease in peripheral resistance, the effect being similar to sudden dilatation of the whole peripheral bed in a normal circulatory system. Compensatory reactions must therefore occur to maintain the circulation through this enlarged peripheral bed and to ensure sufficient oxygenation of the tissues generally in spite of the amount of circulatory blood lost through the fistula. The minute volume flow of blood through the heart must be increased sufficiently to do this. It is brought about by an actual increase in blood volume, by dilatation of the heart to accommodate it, by hypertrophy of the heart to use it, and by increase in heart rate to insure the maximal utilization of it. In animal experiments carried out by Harrison, Dock and Holman <sup>3</sup> it was shown that there is a great increase in minute volume flow of blood through the heart, as indicated by measurement of volume flow through the lungs. Other animal experiments of Holman's <sup>5</sup> also showed marked increase in total blood volume in cases of large fistulas. In a few clinical cases at the Mayo Clinic a post-operative reduction of total blood volume was noted, as determined by the Congo-red method, suggesting that there had been an increased volume, although the pre-operative figures were all within normal limits.

English investigators, <sup>7</sup> however, contend that the heart does not do more work because they believe they have proved that blood flowing through the capillary bed is seriously diminished and general venous pressure is not increased; the heart cannot put forth more blood unless more blood is brought to it, and this is not possible unless general venous pressure is increased. The pressure in the great veins cannot be increased without increasing the pressure throughout the whole venous system, and they have found that the pressure in the peripheral veins is normal. They account for the enlargement of the heart by dilatation due to defective nutrition of the myocardium, coronary blood flow being reduced because of the low diastolic pressure in the aorta. Because of this argument Matas <sup>11</sup> has raised the question: If this is true, why is it that so many persons tolerate their arteriovenous fistulas with comparative comfort in spite of this coronary insufficiency?

After a comparison of the data submitted by the two groups of investigators, the conclusions reached by the first group mentioned appear at present to be the more plausible and convincing, although the work of the other group cannot be lightly disregarded.

#### SUMMARY

Four cases of acquired arteriovenous fistula are reported. It was found in three cases that a determination of the oxygen content of blood taken from a vein in the region of the fistula revealed the presence of arterial blood in

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the venous channel, as would be expected. This test is suggested as a pathognomonic criterion in all cases in which there is doubt as to the presence of an arteriovenous anastomosis.

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# CORONARY DISEASE IN SURGICAL PATIENTS

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AT NO time in life is an adequate coronary circulation more needed and an inadequate one more hazardous than during a major surgical operation. The degree of integrity of the coronary vessels at this time is a subject of grave concern and because of its gravity an accurate appraisal of the pre-operative condition of the vessels unquestionably deserves earnest consideration.

*The Nature of Heart Failure.*—In the appraisal of the surgical risk a clear conception and early recognition of heart failure are essential. Sir James Mackenzie defines heart failure as “ . . . that condition in which the heart is unable to maintain an efficient circulation during efforts necessary for the daily life of the individual,” and continues, “ . . . the main elements composing the circulatory system are the blood, the heart, the blood-vessels, and the nerves supplying and controlling the heart and blood-vessels. The different parts of the circulatory system are so constructed as to facilitate the flow of blood and so aid the work of the heart. The heart muscle supplies the force that propels the blood. So far then, as the efficiency of the circulation depends on the flow of blood the muscular force of the heart is the only factor concerned, and the inability of the muscle to supply a sufficient force is the direct cause of heart failure . . . ” “ The evidence of heart failure in the early stages is entirely subjective. The patient becomes conscious of certain sensations of distress or discomfort on making an effort which formerly he was able to make without experiencing these sensations.

“ As the heart failure advances, these sensations are provoked by less effort. To fully appreciate the nature of heart failure it is necessary to remember that the important factor in maintaining the circulation is the heart muscle. There is a limit to the amount of work that a healthy heart can perform. It is the forcing of the heart to work beyond this limit that produces heart failure. Actual impairment is indicated when symptoms are produced with abnormal facility, as for example, an effort that the individual was wont to perform in the past without any signs of distress. It is the abnormal facility with which the symptoms of exhaustion are produced and not the signs themselves that is the earliest sign of heart failure.”

“ The standard of estimating the heart's strength is found by ascertaining the response of the heart to effort. The standard by which the heart's strength is to be measured is not a fixed standard. It will vary with each individual examined. The field of normal response to effort varies widely in different healthy individuals. Every man knows the amount of effort he

can normally put forth without distress, and this amount of effort is the only practical standard by comparison with which it can be determined, whether the field of the heart's response to effort is restricted. The subjective symptoms of heart failure are never absent when the heart's efficiency is in any way affected. Methods of estimating the cardiac efficiency which do not take into consideration the sensations produced by effort fail to bring out the information essential to a knowledge of the heart's efficiency."<sup>1</sup>

*Symptoms of Coronary Disease.*—Coronary disease reveals itself by definite subjective manifestations. The sensory disturbances following physical exertion more especially, but also mental exertion, range from a mere discomfort regarded as insignificant by the patient to an excruciating agony that forebodes immediate dissolution. The pain which is preëminently the most important symptom is confined to fairly wide but well-defined regions, notably the precardium, retrosternum and epigastrium with or without radiation. The extension of the pain is almost exclusively to the left side—to the arm, shoulder, axilla, wrist, little finger, jaw, gums, tongue, neck, scapula, base of head—but occasionally also to the right. The pain may have its origin in any of the regions of radiation, notably the arm or wrist, and may or may not radiate to the precardium. It is always at some time or other felt in the precardium or retrosternum and its definite relation to physical exertion, immediate or remote, is a characteristic phenomenon. There is another sensory disturbance that may be associated with the pain or may arise independently of it—an expression of myocardial exhaustion that is felt as a constriction of the chest wall, the intensity of constriction varying from a mere tightness to a vise-like grip following exertion. Sudden exposure to cold, prolonged sleeplessness, worry, altercation, are likely to precipitate attacks. Salivation and local or general sweating may occur during a seizure, and profuse urination during or afterward is not unusual.<sup>2</sup>

Greenberg states "a peculiar sensation of a combination of nausea and discomfort in the epigastric area or a fluttering sensation in the substernal region, especially when associated with inability to perform accustomed tasks and coming on after a heavy meal, or periods of prolonged activity is another sign that the coronaries are no longer adequate . . . that the triad of pain, pallor and immobility, even when relatively slight, are sufficient to make a diagnosis and that in the face of normal graphic findings."<sup>3</sup>

*The Central Nervous System.*—The degree of hypersensitiveness of the central nervous system plays an important rôle in determining the significance of subjective symptoms. This aspect of the disease applies especially to women. An extremely hypersensitive woman with mild coronary disease may exhibit symptoms out of all proportion to the actual impairment to the coronary vessels. A careful appraisal of the degree of hypersensitiveness is essential in determining with any degree of accuracy the gravity of the condition. Pressure on the skull behind the ear is a useful method, for this region is relatively insensible to pain in the normal individual. Undue sensitiveness to deep pressure here is indicative of a hypersensitiveness by which



one may discount to a proportionate degree the gravity of the subjective symptoms. Inconstancy of the symptoms, and periods of freedom from distress on exertion, indicate that there is still present a fair degree of cardiac reserve. It is always necessary to measure the heart's efficiency under the most favorable circumstances in order to estimate the heart's ability successfully to withstand strain. As in normal individuals, so in patients with coronary disease, there is a wide variation from time to time in their response to effort.<sup>4</sup>

*Objective Signs.*—Unfortunately physical examination of patients with coronary disease reveals, as a rule, little that will aid in the appraisal of the surgical risk. There are, however, three signs that are peculiarly significant. The first—and it is of vital importance—is reduplication of the first apical sound, indicative of ventricular hypertrophy on the verge of failure.<sup>5</sup> All patients with this reduplication, irrespective of subjective symptoms, that have come to the writer's notice and have undergone a major operation, have died of progressive circulatory failure one to three weeks after operation. Muffled heart sounds at the apex in the absence of emphysema are of value when considered in conjunction with symptoms of distress in response to effort. Extra systoles that are increased by exercise indicate myocardial degeneration and their behavior must be considered in the circulatory appraisal of such patients.

*Arterial Degeneration.*—It is well known that degenerative processes, expressions of old age, take place throughout the body in varying degrees of intensity, and that the location of maximum intensity varies widely in different individuals. The kidneys, brain, heart, muscles, etc., each and all may be the seat of these processes and that organ system in which the process is most marked dominates the picture.

There is a special significance to these facts with reference to the appraisal of surgical patients. Marked degenerative processes in the muscles of the legs may serve to mask well-advanced myocardial degeneration. Subjective symptoms in response to effort are referable to the legs rather than to the heart. Appraisal of the cardiovascular system of this type of patient must depend on physical signs; and the presence of abnormalities in the electrocardiogram which indicates myocardial degeneration offers welcome aid; the absence of such abnormalities is, however, of questionable assistance.

*Sex.*—The importance of sex in the appraisal of the circulatory system cannot be overestimated. In man subjective symptoms and objective signs referable to the circulatory system indicate an impairment of that system of a more serious nature than do the same symptoms and signs in women. The circulatory system of the female will withstand more strain than is indicated by the symptoms and signs, whereas the same system of a male will withstand less than is indicated. That the symptoms and signs are less significant in women is well portrayed by one of the author's cases, a woman, aged fifty-eight; with marked limitation to effort by retrosternal pain, and at times constriction of chest. Marked hyperæsthesia over pre-

cardium. Vessels (radial) thickened. Heart enlarged (moderately). Sounds muffled. Blood-pressure 160-100. Operation radical, amputation of breast. Convalescence was smooth and uneventful.

*Cardiodynamics.*—A healthy heart responds to the demands of increased work by a stronger ventricular contraction. The physiological mechanism responsible for this augmented effort lies in an increased initial tension developed during diastole as a result of increased venous return. In other words, as venous return increases the healthy heart is capable of pumping out a larger volume of blood per unit of time. On the other hand, when alterations in inherent contractility are present, the musculature of the heart cannot respond so effectively to an increased diastolic volume and initial tension during periods of strain (hyperdynamic heart of Wiggers).<sup>6</sup>

When a patient with coronary disease is subjected to a major surgical operation we have superimposed on a hyperdynamic condition of the heart the additional handicap of reduced venous return produced as the result of surgical shock. It is evident in these circumstances that any material reduction in the venous return to the heart will result in progressive circulatory failure. The normal vascular system, to function properly, must contain at all times an adequate supply of fluids, but with alterations in inherent contractility inadequate venous return will eventually produce a physiological impasse.

*Cholecystectomy and Coronary Disease.*—In the appraisal of the coronary surgical risk the nature of the operation is an important factor bearing on the prognosis. An approximate estimate of the shock entailed by the surgical procedure must receive careful consideration. It is the author's belief that a cholecystectomy performed upon a male with even moderate coronary disease will in all likelihood prove fatal without adequate support of the circulatory system. Women, except in rare instances, are in a different category with respect to the necessity of this special support, for the hazard is materially reduced by virtue of the sex. The maintenance of adequate venous return, diastolic volume and initial tension, *sine qua non* in conditions of altered inherent contractility of the heart, is most effectively accomplished by transfusion of whole blood immediately before the operation. Transfusion after the operation may also be necessary; an immediate transfusion is advised if the patient's condition is unsatisfactory.<sup>7</sup> Maintenance, rather than reestablishment, of a sufficient circulation is urgently demanded in these circumstances. The employment of this method, it is believed, would greatly reduce the present high mortality of cholecystectomy.

*Choice of Anæsthetic.*—Loss of consciousness during operation in patients with coronary disease is a decided help to their circulatory system. The majority, if conscious during the operation, develop signs of shock. Cold, clammy perspiration, diminution in the volume of the pulse, and faintness are not uncommon phenomena. Vascular "accidents" (cerebral and pulmonary thrombosis, embolism, etc.) are more prone to occur as the result of using nitrous oxide rather than ether, hence the prolonged administration

of the former to patients with coronary disease is not advisable. A light narcosis produced by ether is more satisfactory. Ether in moderate amounts is a cardiac stimulant, and even in the presence of marked myocardial degeneration does no appreciable harm.

#### SUMMARY

1. A clear conception and early recognition of heart failure are necessary in the appraisal of the coronary surgical risk.
2. Appraisal of the hypersensitiveness of the central nervous system is essential to an accurate interpretation of the gravity of the symptoms in coronary disease.
3. Reduplication of the first apical sound indicates ventricular hypertrophy on the verge of failure.
4. Arterial degeneration in the muscles of the legs may mask advanced myocardial degeneration.
5. Women are superior to men as surgical risks.
6. Adequate venous return to the heart during an operation is a necessity in a patient with coronary disease.
7. Transfusion of whole blood is the most effective method to prevent and combat surgical shock.
8. Without transfusion cholecystectomy in a male with coronary disease is hazardous.
9. The prolonged administration of nitrous-oxide and oxygen is not advisable in patients with arterial degeneration.
10. Ether is the most satisfactory anæsthetic for patients with myocardial degeneration.

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# ASSOCIATION OF HYPERTHYROIDISM WITH DIABETES

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FROM THE CLEVELAND CLINIC

THE association of diabetes with hyperthyroidism is by no means of rare occurrence, although one would be inclined to think so from the sporadic reports in the literature which give but little indication of the actual incidence of this combination of diseases. For this reason, and because it illustrates the importance of an early recognition of the onset of diabetes in these cases, I am reporting here the case of a patient in whom severe hyperthyroidism preceded the onset of diabetes by nearly a year. In this case such a severe stage of diabetes developed that the patient became extremely emaciated. The hyperthyroidism and severe myocarditis persisted even after both lobes of the thyroid gland had been removed, these conditions disappearing only after the removal of a little nodule of thyroid tissue which clinically was about the size of a small marble. When I first saw him this patient was a mere skeleton, too weak to lift his arm, with a basal metabolic rate of about plus 70 per cent., and a blood sugar content of about 400 mg. per 100 c.c. The important feature in this case was that the diabetes was masked, for though glycosuria was present, yet the fasting blood sugar first was at the normal level, a finding which emphasizes the fact that a fasting blood sugar estimation is not a true criterion for the early diagnosis of diabetes; a blood sugar estimation two and one-half hours after a heavy carbohydrate meal being a far better routine procedure.

CASE.—The patient was an unmarried man, thirty-three years of age. There was no significant item in the family history. Of the usual diseases of childhood he had had measles, mumps, whooping cough, and chickenpox. He had also had a Neisserian infection. Aside from these diseases he had been in good health until the early part of 1925, when he first noticed that he was gradually becoming increasingly nervous and later that his eyes were becoming increasingly prominent. A gradual loss of weight accompanied the development of these symptoms and his neck gradually enlarged in front. He had some dyspnoea and also tachycardia, which was increased by exertion. Two years before he came to the Clinic his weight had been 130 pounds, but when first seen (December 29, 1925) his weight was 115 pounds. His pulse rate at this time was 140, blood-pressure 130/60.

Physical examination revealed a thin, nervous man with a bilateral thyroid enlargement and with marked exophthalmos. He had a rapid heart which was slightly enlarged to the left, but there were no thrills, shocks or friction rubs and no murmurs. Otherwise the physical examination revealed nothing of importance, excepting paralysis of the left vocal cord with great œdema of the arytenoid on that side and also some affection of the right cord (false cord). The subsequent course of this patient can best be followed by an examination of Table I and of the charts given in Figs. 1-5.

In this case we were dealing with a very severe case of hyperthyroidism presenting all the cardinal symptoms, the high basal metabolic rate persisting

even after a second lobectomy. At the suggestion of Doctor Marine we instituted the feeding of thymus, which was continued for nearly three months after the second lobectomy without any apparent effect. During this

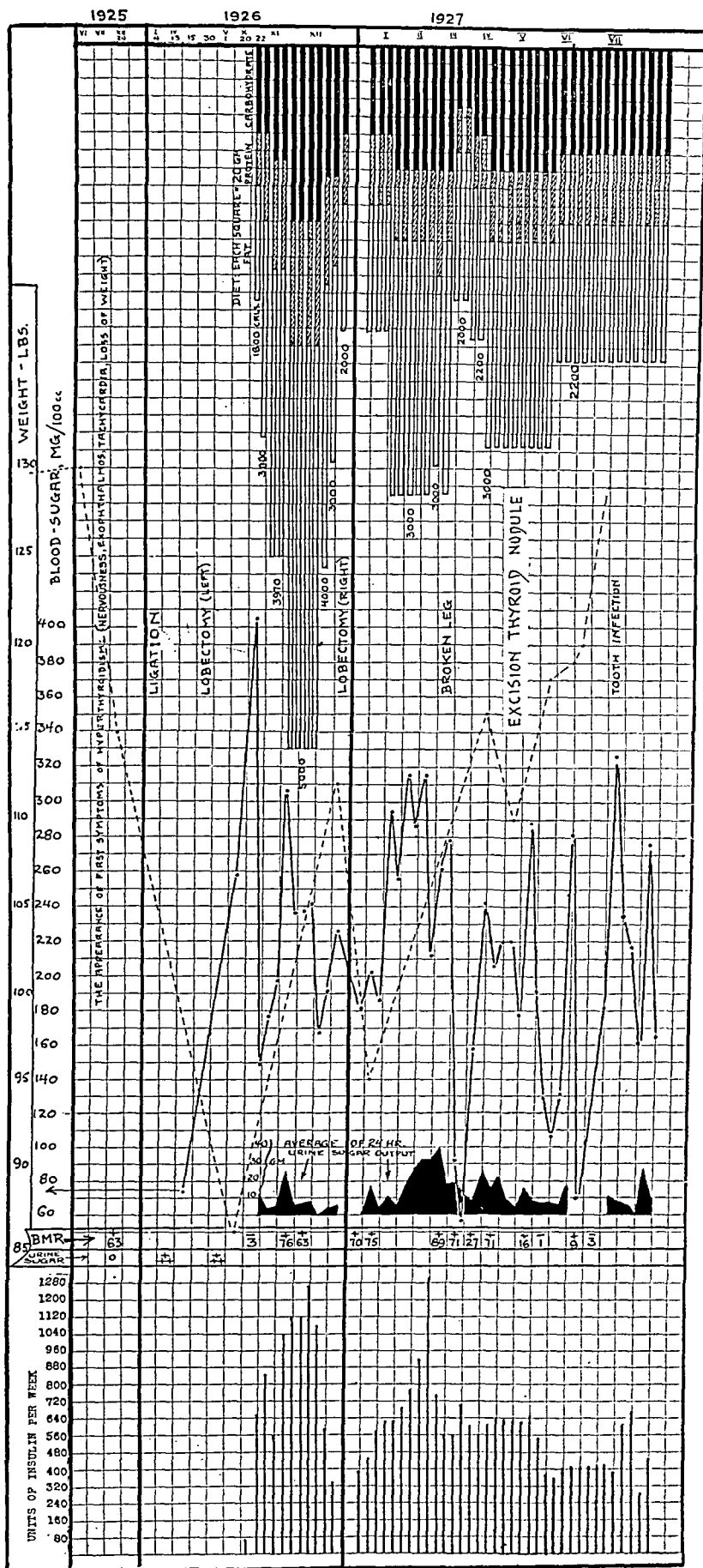
TABLE I.

*Summary of History of Patient with Coincident Hyperthyroidism and Diabetes*

Year	Date	Weight	Glycosuria	Blood sugar mg. per 100 c.c.	B.M.R. per cent.		Operations	24 hr. N. output gm.	Symptomatology
					+	-			
1925	June July	130							Appearance of symptoms of hyperthyroidism—nervousness, exophthalmos, rapid heart, loss of weight. First seen at the Clinic.
1926	Dec. 24	115	neg.		63		Ligation, left		
	Jan. 4						Ligation, right		
	Jan. 7								
	Jan. 10								Discharged from hospital to return for lobectomy. Reentered hospital.
	April 13		3 plus						
	April 15			73					
	April 30						Lobectomy, left		Pulse irregular.
	May 1		3 plus						
	May 11								Discharged from hospital, second lobectomy to be done later. Reentered hospital markedly emaciated.
	Oct. 19								
	Oct. 20			258					
	Oct. 22	86		405		3			Diabetic treatment started. See chart. See photograph 1 (Fig. 6).
	Oct. 23								
	Oct. 29	89.5							Heart irregular. Arrhythmia.
	Oct. 30	91							
	Nov. 8	92.5							
	Nov. 18				76				
	Nov. 27				37				
	Dec. 9				63				See photograph 2 (Fig. 6).
	Dec. 29						Lobectomy, right		
1927	Jan. 18	97			70				
	Feb. 9	103.5			75				See photograph 3 (Fig. 6).
	Feb. 24							12.7	
	Feb. 27							13.44	Feeding with thymus started.
	Feb. 28						Broke left fibula		
	March 3							14.3	
	March 7							11.79	Heart irregular. Arrhythmia.
	March 10							11.34	
	March 12				89				
	March 14							9.5	
	March 16				71				
	March 17							7.84	
	March 21							21.	
	March 24							13.03	
	March 28							12.01	Serum calcium 12 mg. per 100 c.c.
	March 31							7.4	
	April 4	115						9.65	
	April 7				27				
	April 11							10.75	
	April 15				43				
	April 21							14.64	
	April 25	116.75			71				Heart irregular. Arrhythmia.
	May 1							13.5	
	May 2	111.5					Removal of thyroid nodule		
	May 9	110						4.9	Heart more regular.
	May 16	112						8.5	
	May 25	113.75			16				
	May 31	118						9.8	
	June 9					1			See photograph 4 (Fig. 6). Glucose tolerance test. See chart. Heart quite regular, rhythmic and normal in every way.
	June 21								
	June 22				9				
	June 24	120							
	July 27					3	Infected teeth extracted		Severe reaction due to extraction of teeth, face badly swollen.
	Aug. 29	129							Discharged from hospital.

time, while attempting to open a window, the patient broke his left fibula. Some time after the second operation a small nodule was noted on the right side in the thyroid region. This was removed on May 2, 1927, and was found to consist of thyroid tissue. (See pathological reports.) After the removal of this portion of thyroid tissue, the patient began to improve markedly; the basal metabolic rate promptly became normal and remained so; the heart quieted down and he began to gain strength. The outstanding features in this case are that: The hyperthyroidism preceded the onset of diabetes by nearly a year. The patient first noted the symptoms of thirst and polyuria in September, 1926. Glycosuria had

FIG. 1.—Chart showing a summary of the data in the case of a patient with coincident hyperthyroidism and diabetes



been discovered five months before, in April, 1926, while he was in the hospital, just before his first lobectomy, but on the following day his fasting blood sugar was only 73 mg. per 100 c.c. so that the presence of the glycosuria was disregarded, since this is a common finding in cases of hyperthyroidism. Glycosuria was again found on May 1, 1926, shortly before the patient was

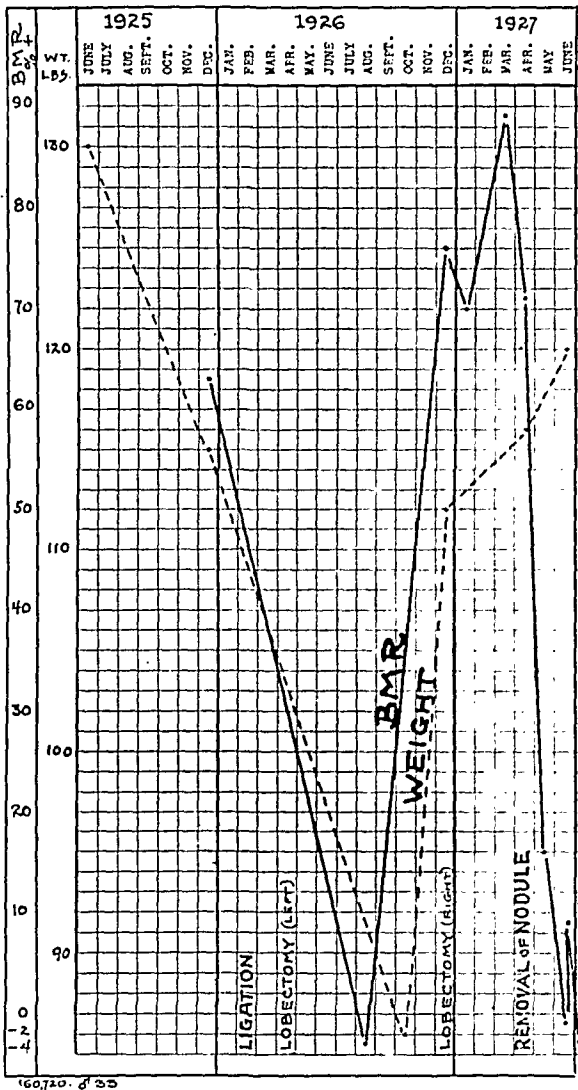


FIG. 2.—Chart showing the variations in the basal metabolic rate and in the weight of a patient with coincident hyperthyroidism and diabetes.

two-fold: (1) the diabetic condition must be controlled, and (2) the patient must be prepared for a second lobectomy. The man was given large amounts of insulin daily (see Figs. 3 and 4) and began to improve immediately, as is shown by Photograph B in Fig. 6, which was taken less than two months later. During this period his weight had increased from 86 to about 95 pounds. He grew very hungry and his diet was increased from 1800 to 3000 calories, but this did not seem to satisfy his hunger, so that it was further increased to 4000, and finally to 5000 calories before his appetite was satisfied. Even on this high diet (200 gm. carbohydrate, 140 gm.

discharged from the hospital after the first lobectomy, but was again disregarded. When the patient reentered the hospital for his second lobectomy he had had the symptoms of thirst and frequency of urination for about six weeks, he was markedly emaciated, his weight having dropped to 86 pounds (see Photograph A in Fig. 6), and he was extremely weak and exhausted. The morning after his admission his fasting blood sugar was 258 and two days later it was 405 mg. per 100 c.c.

The lesson one can draw from the above history is that glycosuria in hyperthyroidism cannot be disregarded, and that even a fasting blood sugar will not always tell the story, for it masked the true situation in this case. A blood sugar determination made two and one-half hours after a meal might have revealed the diabetic condition, and a glucose tolerance test certainly would have done so.

The problem which was before us in October, 1926, was

# HYPERTHYROIDISM AND DIABETES

protein) on many days there was no sugar in the 24-hour specimen of urine (see Fig. 1). On one day the sugar output was 50 gm., but most of the time it was only 5 or 6 gm. in 24 hours, which indicated that the man was utilizing his food, as was shown also by his steady gain in weight. The

TABLE II.

*Observations of Pulse Rate of Patient with Coincident Hyperthyroidism and Diabetes*

Year	Date	Pulse average	Operation
1925	December 29	80	
1926	January 1	120	Ligation, left.
	January 7	109	Ligation, right.
	April 12	130	
	April 19	125	
	April 26	95	Lobectomy, left.
	October 19	145	
	October 26	90	
	November 2	100	
	November 9	100	
	November 16	100	
	November 23	110	
	November 30	130	
	December 7	120	
	December 14	120	
	December 21	130	
	December 28	120	Lobectomy, right.
1927	January 1	150	
	January 8	110	
	January 15	110	
	January 22	100	
	January 29	120	
	February 5	110	
	February 12	110	
	February 19	110	
	February 26	115	
	March 5	120	
	March 12	100	
	March 19	95	
	March 26	100	
	April 2	100	
	April 9	95	
	April 16	95	
	April 23	95	
	April 30	100	
	May 7	130	Nodule of thyroid tissue removed.
	May 14	95	
	May 21	90	
	May 28	90	
	June 4	90	
	June 10	85	
	June 17	90	
	June 24	82	

average sugar output did increase in 1927, when the patient was on a much lighter diet. Once the craving for food was satisfied, we were able to cut down the diet considerably until, when he was finally discharged, he was receiving 2200 calories (carbohydrate, 120 gm.; protein, 80 gm.; fat, 155 gm.) and three daily doses of insulin of 10, 20, and 20 units, respectively.



When the patient was first here he had tachycardia, and his heart was enlarged to the left; and later murmurs, arrhythmia, reduplication of sound and œdema developed. Digitalis and Lugol's solution did not seem to improve the condition of the heart until after the final nodule of thyroid tissue had been removed, when the whole situation changed rapidly and the heart rapidly improved. (Table II.) I am adding here the notes made by Doctor Anderson, who has been examining the man periodically; and also

the electrocardiogram. (Fig. 7.)

"December 12, 1925: Pulse 140. Heart enlarged to left, no thrills, shocks nor friction; no murmurs.

"December 16, 1926: Heart regular, pulse 132. Left border in anterior axillary line.

"March 5, 1927: Pulse 138. Heart enlarged. Systolic murmur with a reduplicated sound.

"April 13, 1927: On digitalis and Lugol's solution since above note. Pulse 94. Faint systolic murmur at apex. No signs of failure except that feet are slightly swollen.

"June 22, 1927: Heart normal in size, rate 80, no murmurs can be elicited. No failure signs, except that the ankles are still œdematous."

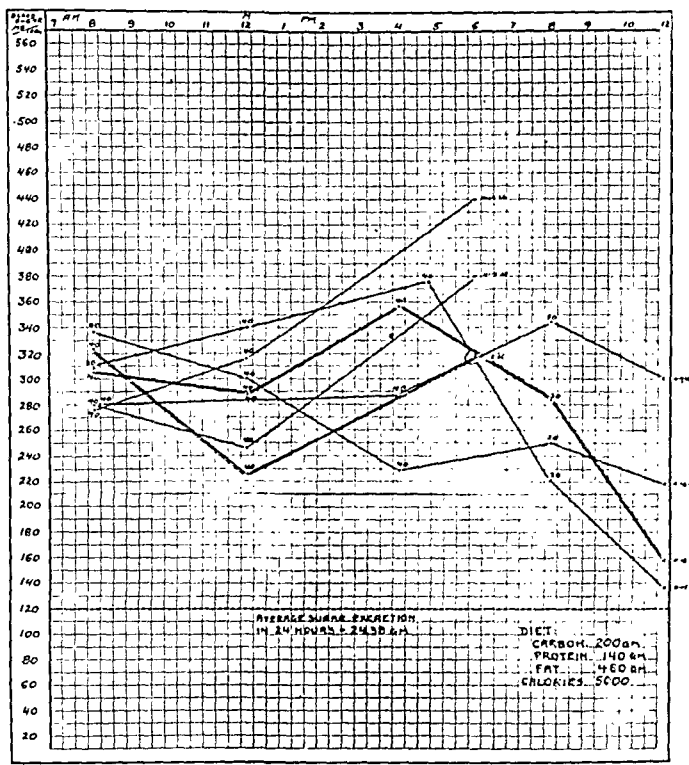


FIG. 3.—Chart showing the blood-sugar fluctuations on six successive days in the case of a patient with coincident hyperthyroidism and diabetes, while he was on a diet of 5000 calories. Insulin dosage is given above dots which indicate height of blood-sugar.

#### PATHOLOGICAL REPORTS (FIG. 8)

"April 30, 1926: First lobectomy.

"*Gross Description.*—One lobe of the thyroid weighing 65 gm. on section presented a moderately firm but rather colloid appearing cut surface.

"*Microscopical Description.*—Sections through the gland showed it to be composed of enlarged acini lined for the most part by slightly to moderately proliferating cuboidal epithelial cells, which in several instances were thrown into papillary folds. There was relatively slight colloid content throughout.

"*Pathological Diagnosis.*—Rather moderate hyperplasia.

"December 29, 1926: Second lobectomy.

"*Gross Description.*—Specimen consisted of a portion of thyroid tissue, weighing 15 gm., 40 × 25 mm. It was deeply lobulated, fairly firm and on section presented a pinkish-gray, glistening surface.

"*Microscopical Description.*—Sections showed follicular hyperplasia with infolding of acinar walls which had papillary projections into the lumina. Lining cells were columnar in type. In some areas the acini were small, lined with broad columnar cells and had no secretory product in the lumina.

# HYPERTHYROIDISM AND DIABETES

"*Pathological Diagnosis.*—Moderate hyperplasia.

"May 2, 1927: Nodectomy.

"*Gross Description.*—Specimen consisted of a portion of thyroid tissue, weighing 35 gm., and measuring 70 x 30 mm. It was deeply lobulated, flabby and had a dark red, moist cut surface.

"*Microscopical Description.*—Sections showed follicular hyperplasia and infolding of acinar walls, which were lined with columnar epithelium. The stroma was scanty and showed distinct lobular markings.

"*Pathological Diagnosis.*—Slight hyperplasia."

## GENERAL DISCUSSION

In Table III I have summarized cases of coincident hyperthyroidism and diabetes which I have found in the literature, including therein my own

TABLE III.

*Cases of Coincident Diabetes and Hyperthyroidism Reported in the Literature*

Author	No. of cases	Total series of cases of hyperthyroidism	Outcome		Year
			Cured or improved	Dead	
Dumontpallier....	1	80		1	1867
Brunton.....	1				1874
Hartmann.....	2				1878
Budde.....	2				1891
Manges.....	1				1899
Müller.....	2				1906
Thompson.....	3				1906
Sattler.....	56 (from literature)			25	1909
Crile.....	1		1		1915
O'Day.....	4		4		1916
Rohdenburg.....	2	1800 (Mayo Clinic) 315 (Mass General Hosp.)	2		1920
Fitz.....	9				1921
Holst.....	10 (glycos.)		10 (by thyroid-ectomy)		1921
Cambridge.....	1		1		1923
Buchanan.....	1		1		1924
Charvat.....	1		1		1926
John.....	40	3171	38	2	1927

series which is to be reported elsewhere. For about two years I have been making a special study of the carbohydrate metabolism in such cases of hyperthyroidism as showed, (1) glycosuria, (2) fasting blood sugar above normal (120 mg. per 100 c.c.), or (3) blood sugar above normal two and one-half or more hours after a meal. This study has consisted chiefly in the study of the glucose tolerance in these cases and basal metabolism estimations. Of the 93 cases of hyperthyroidism which have been included in this study, in forty the glucose tolerance curve was not normal, that is, the curve did not return to the normal level within two and one-half hours after the ingestion of 100 grams of glucose. In a normal individual the curve returns to the normal level within one or one and one-half hours. In some of these cases the height and length of the curve showed a frankly diabetic condition to be present.

It is somewhat difficult to interpret the borderline curves—that is, those which are not frankly diabetic in character but nevertheless do indicate some

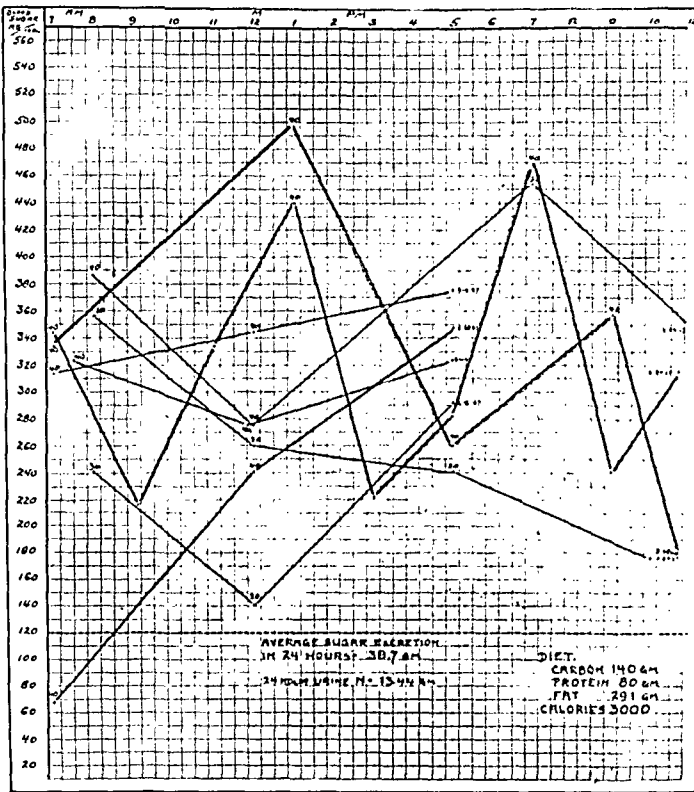


FIG. 4.—Chart showing the blood-sugar fluctuations on eight days during a period of five weeks in the case of a patient with coincident hyperthyroidism and diabetes, while he was on a diet of 3000 calories. The insulin dosage is given above the dots which indicate the height of the blood-sugar.

advance in which cases this will happen, the only safe procedure is to institute an anti-diabetic regimen. Glycosuria is not an infrequent finding among cases of hyperthyroidism.

The presence of glycosuria in itself alone is not, by any means, a proof of a diabetic state, but it does indicate the need of further investigation. In hyperthyroidism we are dealing not only with the normal renal threshold to which blood sugar must rise before it can appear in the urine, but also with the fact that in some cases of hyperthyroidism the renal permeability is increased, an increase which Allen has described as being of toxic origin. I have noted this phe-

disturbance of the carbohydrate metabolism. One may consider that they indicate an impairment of the insulogenic function which may be and often is corrected when the hyperthyroidism is controlled, by whatever means; yet, if uncared for, these cases may drift into a diabetic stage, as I have seen happen in a few cases. I am inclined to consider these as cases of functional diabetes" in which the condition may be corrected under appropriate treatment. In some cases a normal status is reestablished without treatment, but since no one can say in

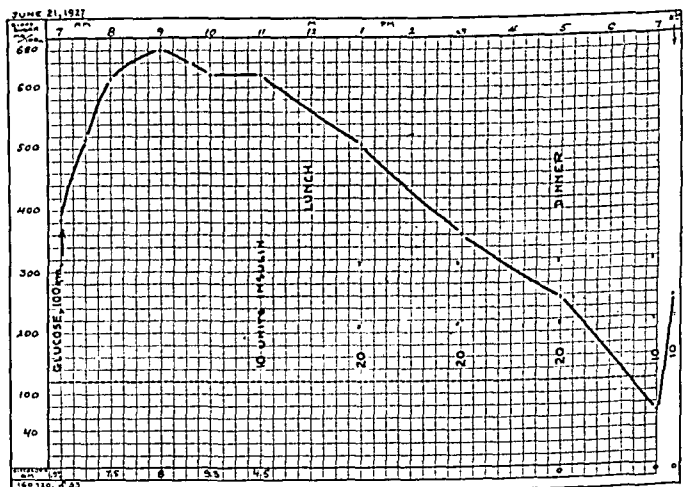
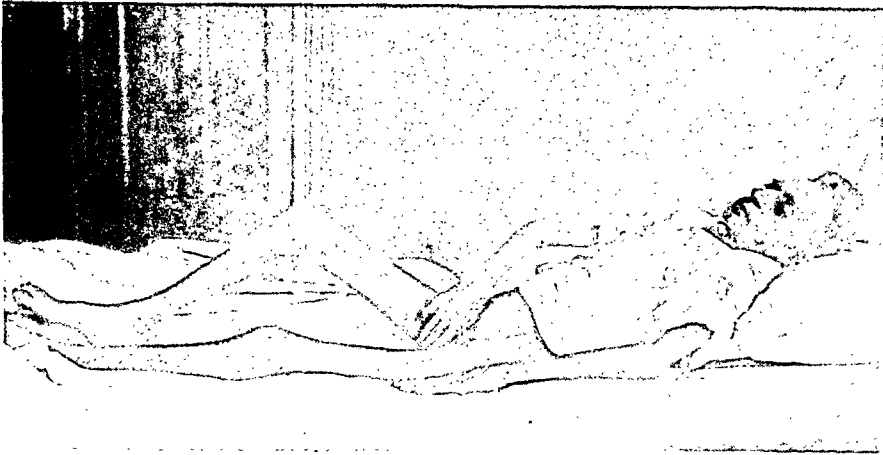


FIG. 5.—Chart showing the curve obtained in a glucose tolerance test made June 21, 1927, seven weeks after the final operation, in a case of coincident hyperthyroidism and diabetes.

## HYPERTHYROIDISM AND DIABETES

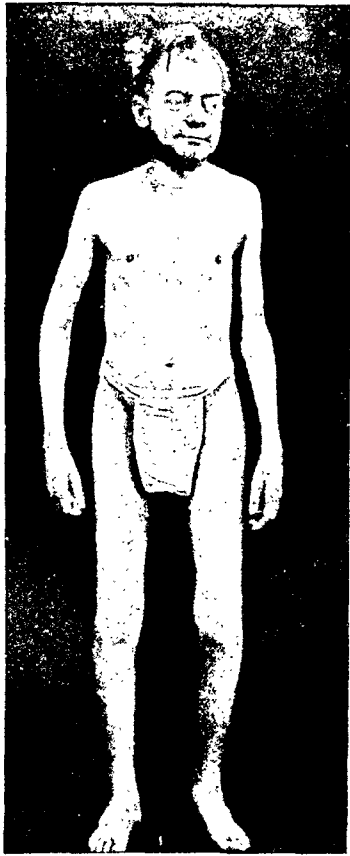
nomenon by comparing glucose tolerance tests made during the acute stage of hyperthyroidism with those made from four to six months after thyroidectomy. This comparison has shown that the sugar excretion during the



10-19-'26 A.



12-9-'26 B.



2-9-'27 C.



6-9-'27 D.

FIG. 6.—Photographs of patient with coincident hyperthyroidism and diabetes. A, photograph made at the time of the discovery of the diabetic condition; B, C, after treatment with insulin had been instituted; D, one month after the final operation.

acute stage of the disease was much larger than after the thyroidectomy, though the coincident blood sugar curves were identical. Increased renal permeability is evidenced by high incidence of a low renal threshold in cases of hyperthyroidism as compared with that in average run of cases. (Table IV.)

As one studies the relationship of diabetes to hyperthyroidism, it becomes

quite evident that in the majority of cases hyperthyroidism precedes diabetes, and a study of the carbohydrate metabolism in these cases leads one to think that hyperthyroidism must be one of the predisposing factors in the development of diabetes. This does not mean, however, that the most severe cases of hyperthyroidism are most predisposed to diabetes, for apparently that is not the case. In a very severe case of hyperthyroidism the glucose toler-

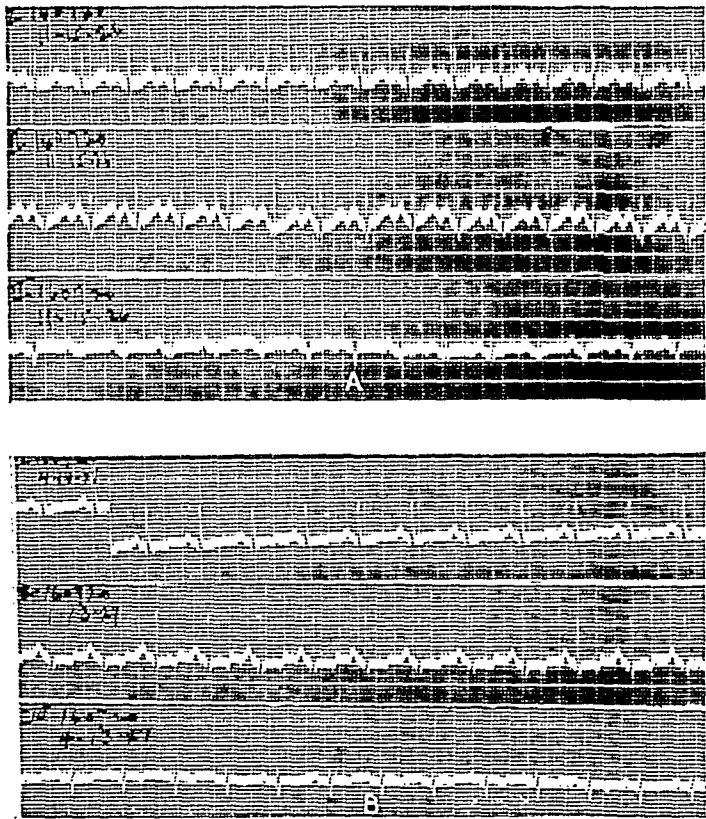


FIG. 7.—Electrocardiographic tracings made in a case of coincident hyperthyroidism and diabetes. A, tracing made November 15, 1926, before the second lobectomy; B, tracing made April 12, 1927, before final operation—removal of a small nodule of thyroid tissue.

ance may be quite normal, while a patient with mild hyperthyroidism may be frankly diabetic. It seems rather that hyperthyroidism is simply a factor which is sufficient to precipitate the onset of diabetes in individuals who, we may say, are already on the road to diabetes, so that the coincident occurrence of any other factor such as infection, overeating, etc., would have the same influence. It is a well known fact that patients with hyperthyroidism consume an enormous amount of food, to compensate for the increased metabolism, and they thus throw a heavy burden on the

insulogenic function of the islands of Langerhans which, if already weakened, will easily become exhausted, with resultant diabetes. Years ago von Noorden<sup>3</sup> called attention to this fact.

CONCLUSIONS

I. Personal observations and cases reported in the literature lead to the conclusion that the association of diabetes with hyperthyroidism is not a

TABLE IV.  
*Renal Threshold in 73 Cases of Hyperthyroidism and Simple Goitre as Shown by Glucose Tolerance Tests*

Blood sugar mg. per 100 c.c.	60-70	71-80	81-90	91-100	101-110	111-120	121-130	131-140	141-150	151-160	161-170	171-180	181-190	191-200	201-210	211-220	221-230	231-240	241-250	251-260	261-270	271-280	281-290	29+
Number of cases . . . .	3	3	0	6	3	11	7	4	4	7	5	4	1	1	3	2	4	1	1	1	1	0	0	1





## HYPERTHYROIDISM AND DIABETES

rare occurrence; and that when this association does occur the diabetes usually develops after the onset of the hyperthyroidism.

2. The appearance of glycosuria in a case of hyperthyroidism should never be disregarded, but a blood sugar determination two and one-half hours after a heavy carbohydrate meal or else a glucose tolerance test should be made in order to determine whether or not the glycosuria indicates a diabetic or prediabetic status.

3. The treatment of diabetes associated with hyperthyroidism does not vary from the treatment of diabetes without this complication, with the



FIG. 8.—Photomicrographs made in a case of coincident hyperthyroidism and diabetes. A, section from specimen in first lobectomy; B, section from specimen in second lobectomy; C, section from specimen of nodule removed in final operation.

exception that, because of the increased metabolism in cases of severe hyperthyroidism, a diet of much higher caloric value than the usual diabetic diet is necessary, and consequently much more insulin is required.

4. Thyroidectomy improves carbohydrate tolerance in all cases of diabetes associated with hyperthyroidism in which diabetes is mild in character; in most of these cases insulogenic function is restored to normal status.

*Addendum.*—The patient whose case is reported in this article returned to the Clinic, July 22, 1927, approximately one month after he was discharged from the hospital, complaining of abscessed teeth. They were extracted and a severe reaction followed, his face becoming badly swollen, etc. There was a marked rise in the blood-sugar for a period of nearly two weeks and the insulin dosage had to be increased, as is usually the case when an infection occurs in a case of diabetes. The basal metabolic rate, however, was not increased and the patient was discharged from the hospital August 29, on the same diet and the same dosage of insulin which he had had before the infection. In Fig. 9 are given the complete data of this case during the three years that the patient has been under observation.

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# CONGENITAL CYSTIC DILATATION OF THE COMMON BILE-DUCT\*

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APPARENTLY a number of patients have died through failure to recognize congenital cystic dilatation of the common bile-duct in time. According to McWhorter, "the correct diagnosis has not been made in any case prior to operation." Since this statement, however, Neugebauer claims to have diagnosed a case prior to operation, and eleven other cases have been reported. These, with the case I am reporting here, make a total of sixty. The condition (in my case) was recognized during an exploratory operation when it was noted that the hepatic and cystic ducts emptied into the superior pole of the cyst. McWhorter says that practically all cases in which diagnosis was not made at the first operation terminated fatally. Of the cases reported later, diagnosis was not made at operation in four (Wyllie, Adam, Zimmer, and Hill and Ramsay). The patients of Adam, Zimmer, and Hill and Ramsay recovered after the second operation. Wyllie's patient died. In seven cases the diagnosis was made during operation. Three of these patients recovered, two died, and the outcome is not stated in two. In one, no statement was made as to time of diagnosis; the patient recovered. In the cases in which a primary choledochoduodenostomy has been performed, three patients recovered and two died. In Wagner's case in which cholecystectomy had also been performed, the patient died. Of the fifty-nine cases reported, external drainage was instituted in forty. All but nine of the patients died, McConnell's, and eight who had some form of internal drainage. In many of the fatal cases secondary choledochoduodenostomy had been performed but the patients were too exhausted to recover. If cystic dilatation is recognized, choledochoduodenostomy or other internal drainage is indicated. The use of external drainage in partial or complete obstruction of the common duct, without correction of its cause, invites disaster in this class of cases as well as in other cases of obstruction of the duct.

CASE REPORT.—A boy, aged twelve, was brought to the hospital, October 20, 1922, because of pain in the abdomen. The first attack was six months previously; it improved after treatment for round-worms. In the last few days he had had three more attacks. Calomel and salts were given with temporary relief. No food had been taken by mouth in the last two days because eating caused discomfort. The pain was around the navel and in the right flank, but did not extend to the epigastrium, the back or the bladder region. There was no nocturia or frequency, and no blood or gravel in the urine. The patient had been well until two years ago when he had a nocturnal attack of severe pain, followed by soreness in the upper abdomen which required morphine.

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\* Read before the Association of Resident and Ex-resident Physicians of the Mayo Clinic, October 6, 1926.

## CONGENITAL DILATATION OF COMMON BILE-DUCT

Examination showed a well-nourished boy apparently not acutely ill. Head, neck and throat were negative on examination. The chest was clear to auscultation and percussion. There were no murmurs or arrhythmia of the heart. The abdomen was tender over the right upper quadrant and in the right flank. There was slight tenderness in the region of McBurney's point. The urine was normal except for a trace of albumin and 15 pus cells in a low-power field. The leucocytes numbered 9600. Röntgenogram of the kidney, ureter and bladder revealed no stone. The diagnosis was recurrent appendicitis. Operation was performed through a high McBurney's incision under ether anaesthesia on the day of admission. The appendix and a Meckel's diverticulum were removed. There was a small amount of clear fluid; the appendix was retrocaecal and rigid, especially at the tip, and distended with gas. Lymph-nodes were considerably enlarged in the ileocaecal region, but not elsewhere. About 50 cm. above the ileocaecal valve a Meckel's diverticulum about 3 by 5 cm. was found. The liver margin, gall-bladder and lower pole of the right kidney were palpated and found negative. Convalescence was uneventful and the patient was dismissed from the hospital on the ninth day.

The patient was readmitted July 5, 1926, complaining of severe pain in the right upper portion of the abdomen. The present illness began about one month after his dismissal from the hospital,

October 29, 1922. He had attacks of pain in the pit of the abdomen followed by soreness in that region. They were not referred to the back. Morphine was necessary for relief. He was nauseated and does not vomit except after hypodermics. Between attacks he suffered no discomfort and could eat anything. There was no belching of gas or high fever with attacks. He had never been jaundiced. The bowels were regular and stools were never white. On examination the patient was found to be well-nourished, vigorous and alert. His color was good, and the pupils equal and reacting to light and accommodation. The tonsils were diseased. The teeth showed moderate caries and pyorrhœa. The abdomen was moderately distended with tenderness and rigidity in the upper right quadrant. No mass was felt at first but following an enema, a smooth tender mass about 7.5 cm. in diameter, moving with respiration, could be palpated in the upper part of the abdomen in the region of the gall-bladder. The urine was normal. The leucocytes numbered 6800. The temperature on admission was 100°, the pulse rate 98, and respiration 20. The tentative medical diagnosis was empyema of the gall-bladder or hydrops, liver cyst, stone in the right kidney, and chronic intestinal obstruction. The pre-operative diagnosis was hydrops of the gall-bladder.

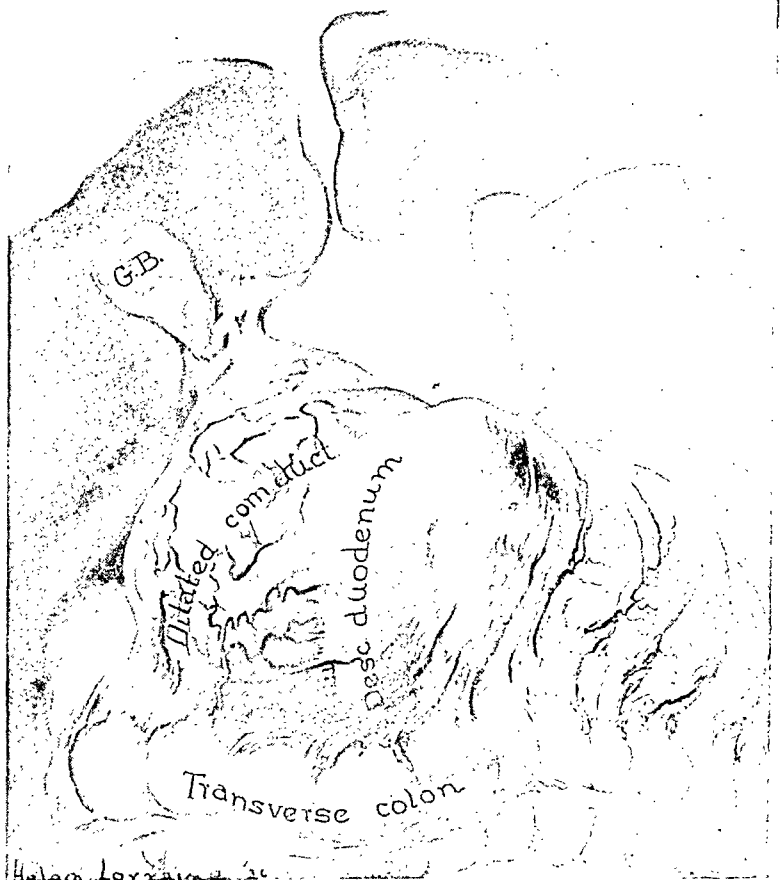


FIG. 1.—Congenital cystic dilatation of common bile-duct containing 400 c.c. bile.

Operation was performed July 6 under ether anaesthesia through a high right rectus incision. A small solid gall-bladder was found, but there was no evidence of stone. There was a large bulging, post-peritoneal, cystic mass between the spinal column and the right kidney and extending beneath the duodenum which reached its highest point on the anterior wall of the cystic mass. The mass extended to the hilum of the right kidney and above to the juncture of the cystic duct with the hepatic. Numerous large vessels could be seen running over the cyst. Extension was greater to the right side of the common duct. The cyst wall was yellowish-white, tough, thick, and fibrous. Owing to its extension to the hilum of the kidney there was some question whether or not it

might be hydronephrosis, but that was ruled out by aspiration of bile with a hypodermic needle. An effort was then made to dissect out the cyst, but owing to marked hemorrhage and mobilization of the duodenum it could not be removed with safety. The cyst was evacuated of 400 c.c. of fairly normal looking bile through a trocar. The sac was then opened, finger introduced for examination, and an ineffectual effort made to find the opening into the duodenum. The wall on the inside was smooth and no stone was present. The cystic duct was normal in size and could be readily seen entering at the upper end of the cyst. The hepatic duct was not dilated. The cyst began at the juncture of these two ducts. Judging from the position of the cyst beneath the duodenum, the distal end of the common duct must have entered the duodenum from the right to the left.



FIG. 2.—Röntgenogram made two months after operation, showing potency of lumen of choledochoduodenostomy.

The liver was smooth and normal in appearance; its edge was thin. The gall-bladder was small and apparently contained no bile, although it was not opened. After failure to deliver the cyst, it was thought best to attach its wall to the duodenum in order to promote internal drainage, so a choledochoduodenostomy was done with a 2-cm. opening into the lateral wall of the second portion of the duodenum with two rows of extra hard catgut without clamps. The duodenum was opened and the duodenal and stomach contents aspirated. The material removed showed considerable bile, indicating that there was still some opening through the common duct. Culture made from bile showed no growth. The wound was closed in the usual manner with two small rubber tissue drains below the gall-bladder near the site of the choledochoduodenostomy. The patient made an uneventful recovery and left the hospital twenty-one days after the operation.

September 9 the patient returned at our request for a Graham-Cole study of the gall-bladder and barium meal test for patency of the stoma of the choledochoduodenostomy and outline of the cyst. He stated that he had been free from all previous

# CONGENITAL DILATATION OF COMMON BILE-DUCT

symptoms. The Graham-Cole test was carried out by giving seven capsules of kerosol by mouth, and a röntgenogram made twelve hours later failed to show a shadow of the gall-bladder or any unabsorbed capsules. The barium outline of the stomach showed it to be low, with a normal duodenal cap. The duodenum observed fluoroscopically gave a faint shadow passing upward in the region of the choledochoduodenostomy, and the films showed a rounded area lying in the region of the common duct superior to the duodenum. This was thought to be a remnant of the former cystic dilatation of the common bile-duct.

Fifty per cent. of the patients were children under fifteen and only 10 per cent. were more than twenty-five years old (Table I). There were nine males and fifty females. The sex was not stated in one case.

TABLE I.  
*Treatment, Type of Operation and Results*

	Patients		
	Total	Living	Dead
Not operated on.....	5	0	5
Drainage only.....	29	2	27
Drainage and later anastomosis attempted.....	4	0	4
Extirpation of cyst and drainage. Bile-ducts ligated in one.....	3	0	3
Choledochojejunostomy.....	1	1	0
Choledocho-enterostomy following drainage.....	1	1	0
Choledochooduodenostomy primarily.....	5	3	2
Drainage and choledochooduodenostomy at second operation.....	6	6	0
Cholecystostomy and hepaticoduodenostomy with excision of sac and cholecystectomy.....	1	1	0
Drainage, secondary choledochojejunostomy and enterostomy.....	1	1	0
Cholecystojejunostomy and drainage; second operation.....	1	1	0
Drainage; second operation cholecystoduodenostomy, third operation choledochogastrostomy.....	1	1	0
	58*	17	41

\*These figures are incomplete as only a short abstract of Yamanouchi's article was available (cystic duct, hepatic duct, gall-bladder and liver; operation and outcome omitted.)

The usual symptoms were recurrent attacks of jaundice, upper abdominal pains and palpable cystic tumor occurring during childhood or early adolescence. McWhorter states that jaundice was absent in three cases. It was never present in my case.

The size of the tumor varied from about 8 to 45 cm., and the contents varied from 200 c.c. to 8 litres. Concretions or incrustations were present in ten cases. The patent lumen in the terminal portion of the common duct was not mentioned or demonstrated in twenty-one cases but was reported present in thirty-six; it was thought to be present in three. In one of these bile was present in the duodenum but no jaundice, only slight jaundice in another, and no jaundice in the third. There was narrowing of the lumen in eleven. There was valve formation at the juncture of the cyst with the duodenal end of the common duct in eight cases. There was a sharp kink or angle in ten cases and no apparent cause of obstruction in seven. Hill and Ramsay state, "It seems clear, therefore, that in all recorded cases there

has been obstruction to the outflow of bile; that the obstruction is partial and intermittent; that the obstruction tends to progress, all patients not operated on having died. While most observers take it for granted that the cyst is congenital, does it not seem far more likely that the obstruction is the congenital anomaly, and the cystic dilatation merely secondary to this, comparable to a hydronephrosis produced by chronic partial obstruction to the urinary outflow?" This explanation seems much more logical but still

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does not explain the intermittance of attacks nor those cases in which symptoms began between the ages of ten and twenty. Associate duodenitis grafted on a congenitally narrowed duct may explain some of the late cases.

The cystic duct was normal in ten; dilated in twenty-two; valve-like formation above, obliterated, narrowed and kinked, respectively in four; dilated in the lower half in four; thickened and elongated in one, and not mentioned in seventeen. The gall-bladder was normal in

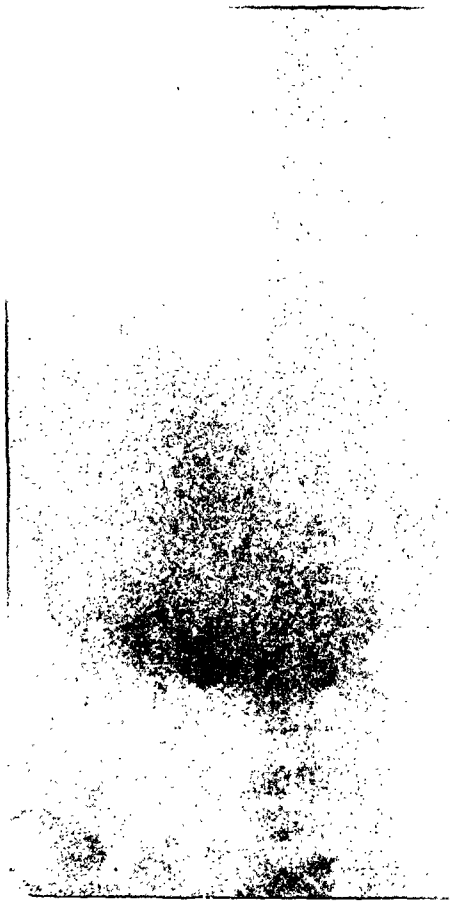


FIG. 3.—Röntgenogram showing size of cystic dilatation two months after operation. Patient free of symptoms.

nineteen cases, dilated in twenty, small in nine, and not mentioned in ten. It was palpated as an independent tumor in six cases. The hepatic ducts were dilated in thirty-three cases; normal in four, thickened in one and not mentioned in twenty. The liver was normal in fifteen cases, enlarged in five; it showed hepatitis in three, cirrhosis in seventeen and icterus in one; it was not mentioned in seventeen.

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## CHOLANGITIS FOLLOWING CHOLECYSTENTEROSTOMY\*

BY OWEN H. WANGENSTEEN, M.D.

OF MINNEAPOLIS, MINN.

SINCE cholecystenterostomy was first practiced by Winiwarter<sup>39</sup> in 1880, it has become a useful method of providing for the escape of bile into the intestine in the presence of an irremovable obstruction in the terminal end of the common bile-duct. Following the more frequent direct attack upon the common duct for obstructions due to calculi, cholecystenterostomy has lost an indication for which it was earlier frequently performed. To-day, the procedure has its best indication in the treatment of obstructive jaundice due to compression of the common bile-duct by carcinoma of the head of the pancreas. Its performance as a method for establishing internal drainage for chronic infections of the biliary system was supported by J. B. Murphy<sup>28</sup> and is advocated by Deaver.<sup>6</sup> Babcock<sup>2</sup> has suggested the extension of the employment of cholecystogastrostomy to the treatment of gastric ulcer and obstinate hyperacidity or pylorospasm not relieved by conservative means.

In the performance of cholecystenterostomy the union is made by choice with the stomach, duodenum or jejunum. In Winiwarter's<sup>39</sup> case both the small intestine and the colon were employed in an attempt to effect a fistulous communication. After six operative procedures an opening between the gall-bladder and colon was established and a seventh operation was necessary to close the fistulæ in the colon and jejunum through which bowel content discharged upon the abdominal wall. In 1887 Monastyrski<sup>25</sup> and Kappeler<sup>13</sup> each performed cholecystenterostomy in one stage; Monastyrski selected a loop in the upper jejunum for the anastomosis with the gall-bladder, while Kappeler employed the lower ileum. To-day, cholecystogastrostomy or duodenostomy is the operation usually done when circumduction of the bile into the intestine by a new route becomes necessary. An anastomosis with the jejunum, permitting of the performance of an entero-anastomosis in the jejunal loop proximally is favored by a few. In the latter method a retrocolic union of gall-bladder and jejunum as first practiced by Prendl,<sup>29, 30</sup> and later by Brentano,<sup>4</sup> permits of the establishment of the communication with the intestine at a higher level. At one time, the Murphy button was frequently used to effect the union, but at the present time in the performance of cholecystenterostomy, the suture method is most widely employed.

Early in the history of the operation, the danger of ascending infection of the bile-ducts was much discussed. Winiwarter<sup>39</sup> had employed the colon for the anastomosis in his case because of the lack of an accessible loop of small intestine at the first operation. In 1894, Michaux<sup>23</sup> reported the instance

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\* From the Department of Surgery of the University of Minnesota.

of a patient on whom Ricard had performed cholecystoduodenostomy for obstructive jaundice. No mention of the nature of the obstruction was made. Numerous calculi were found in the gall-bladder. The patient made a satisfactory convalescence at first and the jaundice disappeared after the operation, but four weeks later chills and fever developed. Fifty-three days after the cholecystoduodenostomy had been done she succumbed to the cholangitis. No post-mortem examination was made. Dujardin-Beaumetz,<sup>7</sup> though making no special mention of having observed the complication of cholangitis after anastomosis of the gall-bladder and upper intestine, warned against its performance because of the danger of subsequent infection. Maragliano,<sup>19</sup> in 1903, stated that Fedor Krause for years had employed the jejunum in effecting the anastomosis with the gall-bladder and performed an entero-anastomosis between the afferent and efferent jejunal loops below to minimize the danger of infection. According to Kausch<sup>15</sup> the same procedure had been in practice at the Mikulicz Clinic for several years. Montprofit<sup>26</sup> recommended and performed a jejunal anastomosis with the gall-bladder en Y much in the manner of the Roux gastro-enterostomy to obviate the complication of ascending infection. Krukenberg<sup>17</sup> twisted the gall-bladder spirally with the same purpose in mind in effecting a direct anastomosis of the gall-bladder with the jejunum. Cholin<sup>5</sup> employed an anastomosis en Y in the manner of Montprofit but twisted the jejunal loop that went to the gall-bladder.

In 1924, Lehman<sup>18</sup> stated that "The surgeon confronted with a permanently blocked common bile-duct and an available gall-bladder hesitated to employ the present operation of cholecystogastrostomy or cholecystenterostomy on account of the probability of the ultimate development of liver infection". In only a few of our text-books on surgery is there any mention made of the danger of cholangitis following cholecystenterostomy. Rowlands and Turner<sup>36</sup> stress the possibility of its occurrence and refer to the case of Ricard.<sup>23</sup> Moynihan<sup>27</sup> says, "To open the small or the large intestine is to give opportunity for infection to spread into the gall-bladder and thence to the liver." In his experience it is never necessary to choose any other part than the stomach or duodenum for the anastomosis.

Babcock<sup>2</sup> states that he has not observed a single instance of clinical secondary infection of the biliary tract in 130 cholecystenterostomies performed by himself and his associates. Mayo-Robson,<sup>21</sup> in one of his early cases in performing a cholecystojejunostomy, made an entero-anastomosis after the method described by Maragliano between the afferent and efferent loops of the jejunum, but only with the point in mind of obviating obstruction of the bowel in consequence of the angulation of the intestine caused by the anastomosis. Following an experience with the operation of cholecystenterostomy in 64 instances he believed the danger of infection to be minimal. Kehr,<sup>16b</sup> although having had a patient die of cholangitis and infection of the liver seven months after cholecystogastrostomy had been



done for carcinoma of the pancreas causing obstructive jaundice, believes the factor of subsequent infection to be of no great concern. In 1913, he had done 60 cholecystenterostomies. Bardeleben,<sup>9</sup> who had considerable experience with the procedure, was also of the opinion that the danger of subsequent infection is slight. In 1906, Bardeleben had done 25 cholecystenterostomies. When he notated his experiences with the method, all instances in which the operation had been done still survived save where the procedure had been performed for obstructive jaundice caused by malignancy. One case was alive and well twelve years later. Bardeleben<sup>9</sup> stated that a dilatation of the bile-passages accompanied by hypertrophy of the walls occurred, together with an hypertrophy of the gall-bladder mucosa and a catarrhal inflammation of the bile-ducts. But he had not observed an instance of cholangitis after union of the gall-bladder and bowel.

In the case of Ricard reported by Michaux,<sup>23</sup> the patient apparently had had occasional rises of fever accompanied by chills before the cholecystenterostomy was done. Inasmuch as no statement is made concerning the nature of the obstruction, the cholangitis that followed in this instance may have been due to an obstruction of the common bile-duct by a calculus. In view of the previous history of chills and fever this is probably the more likely. Such an instance is also reported by Helferich<sup>10</sup> when cholangitis followed a cholecystojejunostomy for a stone in the common bile-duct that was not removed.

But in addition to the undoubted case of Kehr<sup>16b</sup> referred to above, where suppurative cholangitis developed and caused the patient's death seven months after a cholecystogastrostomy had been done for carcinoma of the head of the pancreas, two other instances of cholangitis following cholecystenterostomy have been noted by Kausch.<sup>15</sup>

In the case of a fifty-eight year old woman with obstructive jaundice, Kausch did a cholecystojejunostomy and performed an entero-anastomosis between the jejunal loops. One month later when the jaundice had disappeared, he reoperated with the idea of doing a radical excision of the head of the pancreas. At this operation, yellowish areas thought to be metastases were observed on the inferior surface of the left lobe of the liver. Biopsy of the head of the pancreas only was done and the abdomen closed. The biopsy showed pancreatitis. Three months later jaundice and cholangitis caused the patient's death. At necropsy, a purulent cholangitis was found. There was no evidence of carcinoma.

The other instance was that of a man of forty-nine who had been jaundiced six weeks. At operation Kausch<sup>15</sup> found an operable carcinoma of the terminal end of the common bile-duct. A cholecystojejunostomy with an entero-anastomosis was done. Two months later when the jaundice had disappeared, the patient was reoperated and the terminal common bile-duct with a portion of the head of the pancreas the size of a walnut was excised, together with the upper two-thirds of the duodenum. The common bile-duct was ligated and implanted into the distal portion of the duodenum. The pylorus was occluded and a posterior gastro-enterostomy was done. Bile and pancreatic juice drained from the wound for seventeen days. The patient was able to return to work. Traces of bile were occasionally present in the urine, and the skin

always remained rather dark. A few months later, there was a gradual return of the jaundice and bile could constantly be demonstrated in the urine. Operation was advised but refused. Nine months after the first operation the patient died of cholangitis and cholemia despite a final cholecystostomy. At necropsy, suppurative cholangitis was found. The cholecystenterostomy opening barely admitted a small probe. There was no recurrence of the tumor or evidence of metastasis.

The establishment of an entero-anastomosis between the units of the jejunal loops employed in effecting the union of gall-bladder and intestine failed to obviate the occurrence of cholangitis in these two instances. As a result of this experience Kausch has suggested an added precaution in doing cholecystenterostomy for pancreatitis or operable carcinoma of the pancreas causing obstructive jaundice. He recommends dividing the jejunum about 50 cm. (20 inches) below the duodenojejunal angle. Both ends of the bowel are inverted. The distal jejunum is drawn up and anastomosed side to side with the gall-bladder. A lateral anastomosis is then made between the jejunal segments. The loop of jejunum anastomosed with the gall-bladder is then plicated to narrow the lumen of this channel and to diminish the danger of ascending infection. This is really an anastomosis en Y with a slight modification of Montprofit's<sup>26</sup> and Cholin's<sup>15</sup> methods.

Four years ago the complication of cholangitis following cholecystoduodenostomy was observed in a patient on whom the procedure was performed for malignancy of the head of the pancreas causing obstructive jaundice. A recapitulation of the significant events in that case is the subject of this report.

C. R., Hospital No. 23,856. Male, age fifty-four, was admitted to the University of Minnesota Hospital,† July 7, 1922, with the complaint of painless jaundice of three months' duration. For some time antedating the jaundice, patient had noticed failing strength and up to admission had lost 25 pounds in weight. He has had no chills nor fever nor any abdominal pain. Stools have been acholic for the last two months. Appetite has been poor and patient has been unable to work for about six weeks. No previous operations.

*Physical Examination.*—Patient is moderately emaciated and very deeply jaundiced. Liver extends about 2 inches below the right costal margin. Apart from the liver margin, a mass, fairly movable and not tender, can be made out. The mass is about the size of a lemon and is thought to be the gall-bladder. Chest and heart negative. Weight on admission was 116 pounds. Blood-pressure 140/88.

*Laboratory Examination.*—Stools negative for bile. Fat present in excess. Urine—bile + + + +; occasional granular casts present. Hæmoglobin, 75 per cent.; red blood-cells, 3,700,000; white blood-cells, 10,500; differential normal. Fragility test—hæmolysis began at .40, complete at .20 per cent. NaCl. Bleeding time two minutes; coagulation time six and a half minutes. Blood, Wassermann, negative.

X-ray examination of chest negative for metastatic tumor. Old fibroid tuberculosis at apex of left lung.

Calcium chloride, 5 c.c. of a 10 per cent. solution, was given intravenously on each of three days prior to operation.

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† All the operations on the patient were performed by Dr. A. L. Cameron, Dr. A. C. Strachauer, Chief of the Surgical Service, and Doctor Cameron has kindly permitted me to include the report of this case.

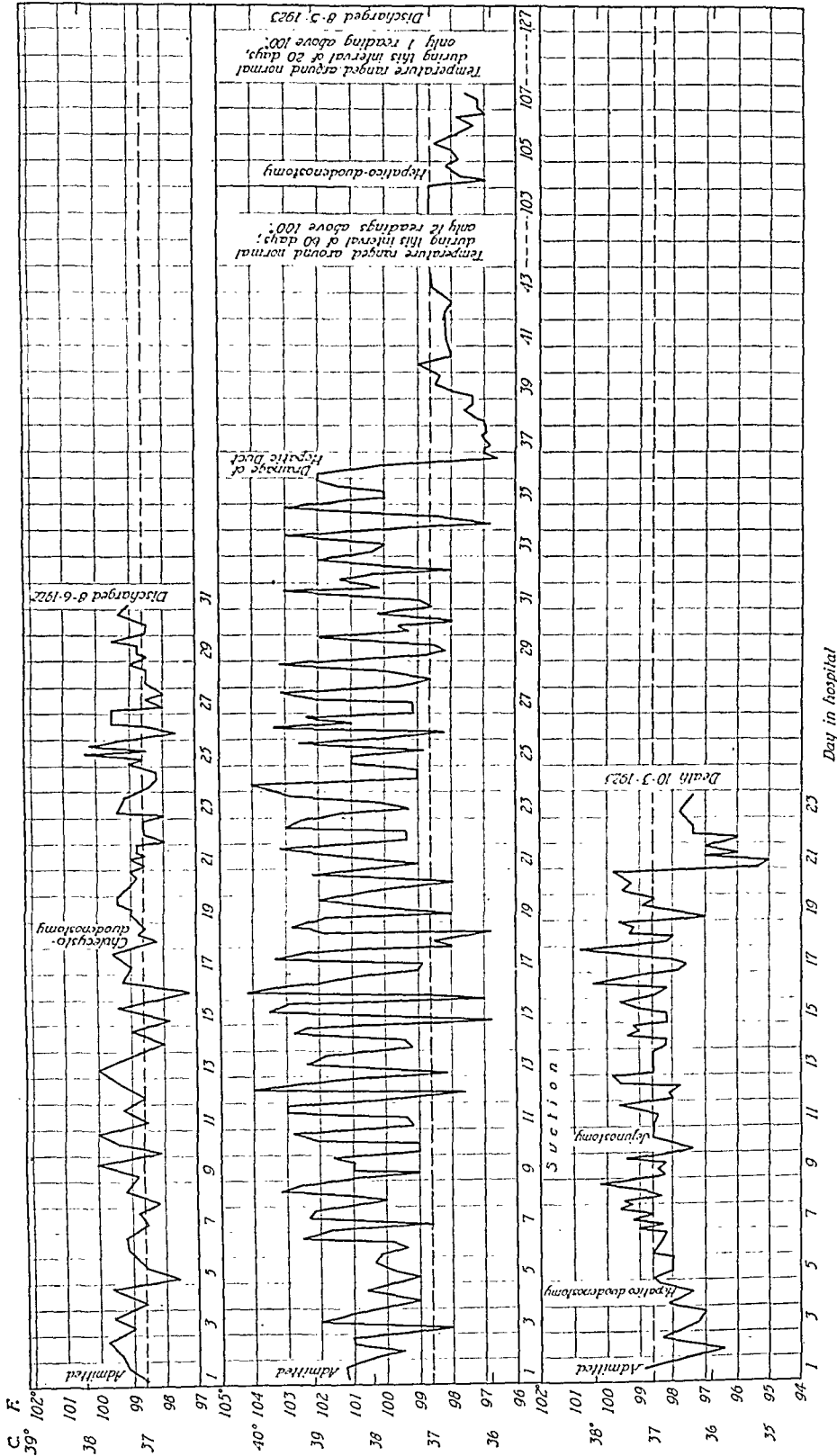


FIG. 1.—The accompanying chart shows temperature variations during the stay of the patient in the hospital on all three admissions. Operative procedures performed are marked on each graph. The length of stay in the hospital in each instance is indicated. The marked fall in temperature following drainage of the hepatic duct on the second admission is apparent.

## CHOLANGITIS FOLLOWING CHOLECYSTENTEROSTOMY

Pre-operative diagnosis: Carcinoma of the head of the pancreas with obstructive jaundice.

Operation, July 24, 1922. Cholecystoduodenostomy. Ether anæsthesia, right rectus incision. At operation the liver was found markedly jaundiced. The gall-bladder was distended, otherwise normal. Spleen was of normal size. In the curve of the duodenum the pancreas was palpated as a hard nodular mass. No lymphadenopathy in the gastro-hepatic omentum was made out. The cul-de-sac was negative. Gall-bladder was emptied by aspiration. Anastomosis made between the gall-bladder and the second portion of the duodenum by the suture method, two rows of chromic catgut being used anteriorly and posteriorly. Following cholecystoduodenostomy bile appeared in the stools and patient was discharged as improved on August 6, 1922.

March 30, 1923, readmitted with the complaint of chills and fever and abdominal pain. Since his dismissal in August, 1922, he had gained about 20 pounds in weight. The jaundice had disappeared entirely by the first of October and the patient had returned to light work. His condition continued good until about the middle of January, 1923. At this time he contracted influenza and shortly began to have chills and fever accompanied by slight jaundice. Since then his health has gradually declined and he has lost considerable weight again. The appetite has been poor and there has been a daily range of fever in the last month from 100 to 102 degrees.

*Examination.*—Patient is moderately emaciated and definitely jaundiced. There is moderate tenderness in the upper right quadrant beneath the costal margin. There is an operative scar over the upper portion of the right rectus muscle.

*Laboratory Examination.*—Stools contained traces of bile. Urine, bile + +; hæmoglobin, 62 per cent.; red blood-cells, 4,164,000; white blood-cells, 22,300. Bleeding time, one-half minute; clotting time, four minutes.

During the next few weeks of observation the patient ran marked elevation of temperature with daily excursions from 99° to as much as 104°.

*Diagnosis.*—Cholangitis following cholecystoduodenostomy. May 5, 1923. Drainage of hepatic bile-duct under ether anæsthesia. The head of the pancreas was found firm, enlarged and nodular. The common bile-duct was apparently occluded. A catheter was inserted into the hepatic duct. Following this there was an immediate drop in temperature. Patient began to feel better at once, appetite improved and patient was up and around. The temperature was sustained at a normal level save for an occasional rise.

On July 11, 1923, an attempt was made to anastomose the hepatic bile-duct to the pyloric end of the stomach. The fistulous tract present was dissected out with care. An anastomosis was made with the hepatic duct and the pyloric end of the stomach. However, this procedure was not successful and in the next few days bile again escaped from the wound and was continuing to do so when the patient was discharged from the hospital on August 5, 1923.

September 10, 1923, the patient was readmitted and an attempt was made again on September 13 to anastomose the hepatic duct to the duodenum. Due to the obliteration of anatomical planes and to the presence of considerable scar tissue the operation was attended with considerable difficulty. An anastomosis was made between the hepatic bile-duct and the duodenum. Penrose drains were inserted and the abdomen closed.

During the next few days there was considerable drainage of bile and what was thought to be duodenal content from the wound. Suction was applied and on September 19 jejunostomy was done. Patient died on October 30 of peritonitis.

A post-mortem examination was performed by Dr. John F. Noble of the Department of Pathology of the University of Minnesota, through whose courtesy the following report is made available. Only the description of the significant findings are listed.

# ACID AND ALKALI BURNS OF THE EYE

AN EXPERIMENTAL STUDY

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THE important chemical burns of the eye like those of the skin are mainly due to acid or alkali. It has generally been taught that the best method of treatment of such injuries is the use of some neutralizing agent, either alone,<sup>1</sup> or following irrigation of the eye with water.<sup>2, 3</sup> A year ago, Davidson<sup>4</sup> showed conclusively that the intensity of an acid or alkali burn of the skin is increased by use of a neutralizing agent and demonstrated that dilution is more effective than neutralization as a first aid method.

The experiments on which this report is based follow closely the work of Davidson on chemical burns of the skin. The eye differs from the skin in presenting a continually moist surface. When an irritant is applied to the eye there is rapid outpouring of tears which tends to dilute and mechanically remove the offending material. Also the eye has no horny layer to protect it from injury.

In any attempt to save sight after a chemical burn, the cornea of the eye is the important area. Any opacity of this region causes loss of vision. The cornea is made up of several transparent layers. On the outer surface is a layer of epithelium limited below by Bowman's capsule. Beneath this are stroma cells which are limited on the inner surface by Decemet's membrane. To cause an opacity of the cornea, the injury must penetrate through Bowman's capsule. If the injury penetrates entirely through the coats of the eye, collapse of the eye results. Therefore, the extent of the permanent damage in the eye resulting from a chemical burn is directly related to the depth of which the burn is allowed to penetrate. There are three things which control this: (1) The strength and character of the chemical. (2) The length of time before initial treatment. (3) The type of initial treatment.

There is considerable confusion in the literature about the best method of treatment. This fact and the fact that there has been no controlled work



FIG. 1.—Showing a rabbit's eye forty-eight hours after a twenty-five-second exposure to 20 per cent. sulphuric acid. The acid was neutralized with sodium bicarbonate 2 per cent. Note the cloudy cornea.

done, made it seem desirable to study the effects of various treatments in the laboratory where conditions could be controlled. Rats and rabbits were



FIG. 2.—Showing a rabbit's eye forty-eight hours after a twenty-five-second exposure to 20 per cent. sulphuric acid. The eye was treated with vigorous washing with water. The cornea is clear. Compare with Fig. 1.

anesthetized and the irritant instilled into the eye. At a set time by stop watch the initial treatment was given. This treatment consisted of irrigation from a rubber syringe with water or other solutions. The eyes were observed at twelve hours and every day for at least two weeks. Some of the eyes were examined microscopically. Control eyes without treatment were also observed. The time before treatment was varied to determine the length of time a given chemical could be left in the eye without causing a permanent opacity of the cornea after various treatments. It must be borne in mind that the rat's eye differs from the human eye, not only in thickness of the cornea, but in having a smaller amount of tears. So that the severe results noted in the rat would not be seen in the human. A drop of a chemical in the human eye would within a second be diluted at least ten times by the tears. Also the human eye is larger and a drop would not necessarily strike the cornea and interfere with vision before it had been diluted. The time increment, therefore, must be considered as only relative for clinical purposes.

As the rat's eye does not reproduce well, rabbits were used for the experiments of which photographs were taken.

*Sulphuric Acid.*—The action of concentrated solutions of sulphuric acid on the cell is the splitting off of the O and OH ions with resultant carbonization. Acid albumins are also formed.

Concentrated or 95 per cent. sulphuric acid in the eye without treatment completely destroyed the eyeball. The rat died in forty-eight hours, the destruction having penetrated to the brain, carrying infection with it. When the acid was neutralized with 2 per cent. sodium bicarbonate after ten seconds of burn, a similar destruction occurred, death coming in two or three days. The eyes treated by vigorous washing with water after a similar length of time were not collapsed but resulted in very marked scarrings of the cornea. None of the rats died.



FIG. 3.—Showing a rabbit's eye two weeks after exposure to 95 per cent. sulphuric acid. No treatment was given. The eyeball is completely destroyed.

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Using 50 per cent. sulphuric acid the control eye showed very marked scarring of the cornea. Seven out of eight eyes treated with sodium bicarbonate in 10 to 15 seconds were similarly scarred. Of the eight eyes irrigated with water, seven had normal eyes in two or three days, one only showing some opacity of the cornea. Using 30, 20 and 10 per cent. solutions similar results were obtained.

A graph was made of the relative time a solution can be left in a rat's eye with the two treatments before causing a permanent opacity. This shows that the period of safety is lengthened 10 to 25 seconds by water treatment. These added seconds give us a greater possibility of saving sight. It further shows that at any length of time after a burn, water is better than neutralization, of course, excepting a period of burn sufficient to cause complete destruction, after which neither treatment is of any benefit in saving sight.

*Nitric Acid.*—The action of nitric acid on the cell is, according to Sollman, a withdrawal of water, union with the cell compound to form acid albuminates and softening of the epithelium and connective tissue. A characteristic xanthoproteic reaction takes place. The removal of nitric acid before serious damage has been done is more difficult than sulphuric acid. Using 68 per cent. nitric acid the untreated and the eyes treated with 2 per cent. sodium bicarbonate all were completely destroyed. The eyes treated with water irrigations showed marked



FIG. 4.—Showing a rabbit's eye two weeks after exposure to 95 per cent. sulphuric acid for ten seconds. The eye was treated with sodium bicarbonate. Note the partially degenerated eyeball.



FIG. 5.—Showing a rabbit's eye two weeks after ten seconds exposure to 95 per cent. sulphuric acid. The eye was treated with vigorous irrigation with water. The cornea is cloudy. Compare with figures 3 and 4.

scarring of the cornea, but none were destroyed. After a burn of 15 seconds or longer, the eyes were destroyed despite the treatment.

Using a 30 per cent. solution, 100 per cent. of the eyes neutralized were completely degenerated, but only 40 per cent. of the eyes washed were lost. The remaining 60 per cent. of eyes treated with water resulted in permanent scarring of the cornea.

With 20 per cent. nitric acid, the control rats showed very marked scarring of the cornea. After a burn of from 5 to 20 seconds, 60 per cent. of the eyes treated with either water or sodium bicarbonate solution resulted in transparent corneas. However, the water-treated eyes cleared up two to three days before those in which sodium bicarbonate was used. The eyes irrigated with water showed some slight permanent opacity.

Ten per cent. nitric acid can remain in a rat's eye, 5 minutes, and result in a clear cornea if treated with water irrigation. If the acid is neutralized after a similar time, a permanent opacity results.

The question was raised—"Is neutralization better than washing alone, if it is

followed by or follows irrigation"? Eight eyes were neutralized first and then washed. The results in these were better than with neutralization alone, but none equalled the end results without preliminary neutralization. The same was repeated with neutralization after the irrigation. The results were practically the same as washing alone, which makes it seem that neutralization is not of added benefit, after good irrigation.



FIG. 6.—Showing a rabbit's eye two weeks after a ten-second exposure to sodium hydroxide 40 per cent. The alkali was neutralized with acetic acid 2 per cent. Note collapse of eye and contraction of lids.

as treatments. As carbolic is not soluble in water in suitable strengths, the fractional solutions used to produce a burn were dissolved in glycerine.

Using 87 per cent. carbolic, the untreated eye was completely destroyed. Eyes treated immediately after the burn resulted in clear corneas when water or sodium sulphate 4 per cent. were used. Using alcohol 25 per cent., the cornea showed some slight permanent opacity. When the acid was left 10 seconds or longer before treatment, 60 per cent. of the eyes treated with water resulted in transparent corneas, only 25 per cent. after alcohol irrigation and 10 per cent. after sodium sulphate treatment.

A 50 per cent. solution of carbolic in glycerine left in the eye without treatment, caused a very opaque cornea as an end result. After a burn of 10 seconds or longer, 30 per cent. of the eyes treated with any treatment had transparent corneas in three to five days. The treatments used were water, alcohol, sodium sulphate and glycerine. Twenty and 10 per cent. solutions gave similar results.

From the fact that water is as good or better than alcohol or glycerine, the solvents of carbolic, we feel that dilution does not play the important part in stopping the damaging effects of the chemical.

*Sodium Hydroxide.*—The caustic alkali in strong solutions combine with the cell albumin and fats to form alkaline albuminates and soaps. Due to the marked avidity

*Phenol.*—The problem here is somewhat different than in the two preceding groups. Although commonly spoken of as an acid, carbolic is only very slightly acid to litmus. It is, however, a protoplasmic poison. It precipitates the cell proteins loosely, allowing the poison to penetrate deeply, causing death of the cells. Wells states that phenol may cause necrosis even in dilute solutions, due to the formation of hyalin thrombi of agglutinated red blood corpuscles. The question is not one between neutralization and irrigation, but between various irrigating solutions. Water, alcohol 20 per cent., sodium sulphate and glycerine solutions, were used



FIG. 7.—Showing a rabbit's eye two weeks after ten seconds exposure to 40 per cent. sodium hydroxide. The eye was treated with vigorous washing with water. Note the cloudy cornea. Compare with Fig. 6.



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for water, the alkali penetrates deeply under the epithelium, causing necrosis. Davidson found in the skin a latent period before cell life was destroyed. We did not find any latent period in the eye. This difference is due to the lack of a protecting horny layer. The action is rapid on the unprotected cell as found in the cornea. The rapidity of action makes it difficult to obtain an eye useful for vision with any treatment.

Using a 40 per cent. solution both the control and the eyes neutralized with acetic acid, 2 per cent., were completely degenerated, with death of the rat in two to three days. The rats which were treated with water resulted in cloudy cornea in 50 per cent. of the cases, and complete degeneration in the remainder. No rats died. In the weaker solu-

### SULPHURIC ACID

RELATIVE DEPTH OF BURN

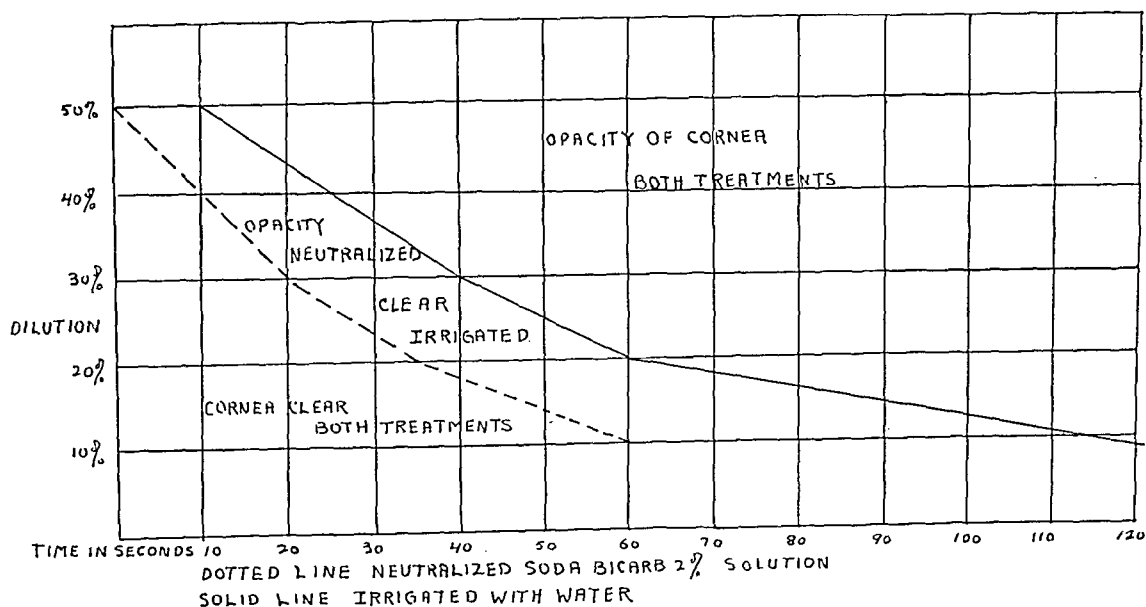


Fig. 8.

tions similar results were obtained, none of the eyes neutralized were saved and only about 50 per cent. of the eyes washed would be useful.

*Ammonium Hydroxide.*—The action of ammonia according to Sollman<sup>5</sup> is a penetration through the outer layers of the epithelium to form fluid in the lower layers with death of the cells. A 28 per cent. solution was used in the laboratory to produce burns. Acetic acid 2 per cent. and water were used as treatment. The cornea was destroyed when no treatment was given. When the alkali was neutralized with acetic acid 2 per cent., even after one minute of burn, a cloudy cornea resulted. However, when the eyes were irrigated with water any burn up to four minutes' duration resulted in transparent cornea. After five minutes sufficient damage had already been caused to result in permanent scarring.

### DISCUSSION

It has been demonstrated by the experiments that neutralization of the caustic acids and alkalis cause increased damage to the cornea. This added damage may be the result of heat produced locally by the chemical reaction. Also there is the theory that water supplies the hygroscopic caustics with the necessary H. and O.H. ions, thus preventing their withdrawal from the cell. Free O. and O.H. ions in the cell are incompatible with cell life.

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### CONCLUSIONS

(1) It was found that, regardless of the concentration of a chemical or of the time interval, the best result is obtained with irrigation and that neutralization definitely causes damage.

(2) Experiments show that neutralization is not of added benefit after thorough irrigation and causes more damage when done before washing than washing alone.

(3) The mechanical removal of the chemical is the most important factor. This is shown in the experiments with carbolic which substance is not soluble in water.

(4) The tremendous importance of time before first aid is given has been demonstrated.

(5) It has been further shown that after a certain time of exposure for any concentration irreparable damage has been done.

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## INDELIBLE INK-PENCIL INJURIES

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SUBSEQUENT to the widespread introduction into commerce of aniline and its dyestuff derivatives, a new and interesting chapter in medicine had to be written on both the harmful as well as the beneficial effects of these chemicals. On the one hand, there has come to recognition a knowledge of the baneful effects of aniline in the production of vesical papillomata and of the various forms of dermatitis, while on the other hand, there has developed a large traffic in drugs of aniline derivation for either oral or intravenous administration. Much has been written on the use of the relatively weak concentrations of this type of chemical agent, though but little has been said of the dangers incident to the exhibition of the more concentrated solutions.

The injury due to particles of indelible pencils is of this category. Because of its relative infrequency, practically no attention has been paid to the condition in this country, although it has received rather exhaustive consideration in the German literature. For a long time before its recognition by the surgeons, German ophthalmologists were all too well acquainted with the terrible effects resulting from the accidental injection of indelible ink particles into the conjunctival sac of school children. As a consequence of their agitation, the use of such pencils was prohibited in the schools. Indelible pencils are now used almost exclusively by clerks, who, therefore form the large bulk of patients suffering from injuries caused by the accidental implantation into hand or finger of a piece of the lead. Though uncommon, the injury, in this respect, may be almost considered as an occupational disease with the hands or fingers as the sites of selective involvement. In 1914, during the treatment of a patient who had stuck his finger with an indelible pencil, Erdheim was stimulated to a study of this condition. In the few cases which have since been noted in the literature, practically no additions have been made to the observations and conclusions originally reported by Erdheim in 1914 and subsequently in a more extensive communication in 1919.<sup>1, 2</sup> The writer, therefore, asks for indulgence if the report of a single case be made the occasion for calling the attention of the profession in this country to this interesting and unusual condition and for reviewing briefly the state of our knowledge on this subject.

S. W., a clerk, aged twenty-seven, was first seen in the spring of 1924, three days after having punctured the left index finger with an indelible ink-pencil. During the first two days the patient paid no attention to the injury, but on the third day noticed a slight rise in temperature, headache and a general feeling of malaise. On the following day he presented himself for treatment. The ball of the terminal phalanx of the left index finger was moderately swollen. At its centre was a small punctured wound, with a purplish discoloration from which a moderate amount of thin purplish serous dis-

charge issued. In the depths could still be felt the fragment of the indelible pencil. The patient complained of surprisingly little pain on pressure about the wound. The epitrochlear gland on the left side was palpable and enlarged. There was a slight increase in temperature. The patient still complained of a feeling of malaise but was not acutely ill. No attempt was made to remove the fragment of pencil, but the patient was advised to have the whole area excised. This he refused and the more conservative treatment by finger baths and wet dressings had to be instituted. Unfortunately, no X-ray photograph of the finger was made either at this time or subsequently. After the lapse of about six weeks under this form of conservative therapy, a large core of necrotic tissue separated and the wound soon began to heal. At the end of about eight weeks, the wound had completely healed, leaving a deep depressed scar adherent to the bone. There was, at no time, any evidence clinically of bacterial infection. There was no lymphangitis, œdema of the dorsum of the hand, nor any suggestion of tendon sheath infection. When discharged, the patient had complete use of the finger and when seen some six months later reported having had no trouble since the healing of the wound.

To even a casual observer the difference between the reaction caused by this type of foreign body and that occasioned by the more common types of foreign body must be apparent. In the latter case, the injuries are to be attributed either to mechanical insults such as fractures, the tearing of vessels and other structures or to the infection which develops secondarily in the presence of the foreign body. It is true that metallic substances, such as gold, platinum, silver, lead, etc., have been known to dissolve in the tissue juices and lead to greater or lesser symptoms of general toxæmia. The significance of lead in this respect has recently been emphasized by several authors, among them Habs,<sup>4</sup> who have confirmed Tuffier's original observation of lead poisoning developing from a bullet retained in a soldier's body. To this extent, these injuries may be compared with those caused by indelible pencils. But because of the relatively low solubility of such metallic substances, this complication must be looked upon as extremely unusual. Though the possibility of its occurrence must not be denied, it seems that no too great weight need be placed upon the report of sporadic cases. In the case of the aniline dyestuffs, however, the relatively high solubility of the chemical determines the rapid development of toxic symptoms. In fact, the whole clinical picture is so altered that the injury due to the presence of the foreign body *per se* becomes of secondary importance while the chemical necrosis assumes the primary rôle.

In studying the effects of indelible pencil injuries to the eye, Kuwahara<sup>5</sup> showed experimentally that graphite alone in the conjunctival sac evoked merely a foreign body reaction, while indelible pencil particles called forth exactly the same response as the aniline dye used in the manufacture of the pencils. From this the natural conclusion was drawn that the noxious agent was the soluble dye and not the inert graphite which acted as the carrier of the dye. Carrying the analysis somewhat further, Vogt<sup>6</sup> showed that aniline dyes could be divided into two main categories on the basis of their action on tissues. He showed that the acid and neutral dyes were almost without effect while the alkaline aniline dyes were extremely harmful to

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tissue. When the basophilic nature of the cell nucleus is recalled, the mechanism of this reaction will be easily comprehensible as a direct chemical combination of the alkaline drug with the nuclear acids leading to the death of the cell. Of a series of different chemicals tested, it was found that those belonging to the triphenylmethane group, of which methyl violet is a member, were fraught with the greatest dangers to the existence of the cell. In a general way, this agreed with the results of Erdheim's experiments in which he showed that the aniline dyes increased in the degree of their tissue toxicity from those that were green, through yellow, red, brown up to the most noxious blue.

In cases examined as early as one hour after the injury, very little is seen beyond slight irritative reactions and a tendency to hemorrhage but no necrosis. In cases observed after the lapse of twenty-four hours, there is definite evidence of necrosis of surrounding tissues. As a result of his painstaking animal experiments, Erdheim was enabled to reconstruct the course of events initiated by the introduction subcutaneously of an aniline dye in the form of an indelible pencil, in the following manner. Immediately after the subcutaneous imbedding of the dyestuff, there is a rapid outpouring of tissue juices and a sort of pseudo-cyst is formed. At first this cyst is tensely filled, but as the dye dissolves, the fluid gradually diffuses into the surrounding tissue spaces. As time goes on, the cells which come in contact with this highly concentrated dye solution are stained and die. The further the dye diffuses into the tissues, the less its concentration until a point is finally reached where its potency is insufficient to cause cell death. Beyond this region which really determines the site of the line of demarcation, a protective barrier of leucocytes is established and still further beyond this a zone of granulation tissue. In a typical cross-section, therefore, there would be seen four well-defined concentric zones; a central cyst-like space in which the aniline foreign body lies, then a zone in which chemical necrosis of the tissues has taken place, next the region of the leucocytic wall and finally the reparative area of granulation tissue. The two innermost of these four zones are destructive in nature, and may involve tissue of any type, whether soft type or bone. Even in the case where the concentration of the dye is insufficient to lead to actual necrosis and subsequent sequestration of the bone of an involved finger, an undeniable osteoporosis due to chemical interference with the nutrition of the bone can be demonstrated on the X-ray photograph. The necrosis is completely aseptic and neither leucocytes nor bacteria are found in the area bathed by the lethal fluid. As a consequence, the definitive processes of repair are held in abeyance until the whole necrotic mass has been extruded after its separation at the line of demarcation.

Clinically, there are two types of reaction to the sort of chemical injury induced by indelible-ink pencils. In the type characterized by the appearance of only local symptoms, there is usually nothing more to be seen than a small punctured wound. The wound and the surrounding tissues are highly dis-

colored and from the mouth of the wound there issues a moderate amount of dye-stained serous fluid. There is no evidence of inflammatory reaction and beyond a slight feeling of discomfort, the patient seldom complains of pain. This is doubtless due to the fact that the nerve endings are involved in the same necrotic process as the other neighboring tissues, and secondly, to the fact that in the absence of inflammatory reactions, there is no increase in the tissue tension. Methyl violet seems to be most common in the production of this type of reaction. In the development of the general type of reaction, methyl blue appears to be even more potent. The patient presents the appearance described above, and in addition usually complains of headache, fatigue, slight rise in temperature, and general malaise. These latter symptoms can only be attributed to a general toxic effect resulting from absorption and distribution of the dye by the lymphatic system. Left untreated, the affection is extremely chronic and shows no tendency toward healing until the extrusion en masse of the necrotic tissues.

In cases treated shortly after injury, Glass<sup>3</sup> has shown that incision, curettage and lavage of the wound with a 1 per cent. solution of trypan flavin is frequently sufficient to result in healing. On the other hand, in cases treated at a relatively late stage, wide excision and even amputation is often necessary to bring about cure. The attempt to remove the offending particles of dyestuff through the small puncture hole by the use of a forceps is of all means the worst that can be employed. The result usually is that the foreign body is broken in many smaller fragments, the protective wall is injured and the tissue spaces opened for the wider and more rapid diffusion and absorption of the injurious solution. That a wound caused by an indelible pencil may heal under a strictly conservative form of treatment is shown by the case above reported. But, while this may occur occasionally, the risks involved far outweigh the benefits which may attend such a course. It is felt that the only rational form of therapy, the one which involves radical procedure with the purpose of conservation of tissue and function, lies in the wide excision of the wound and its contained foreign body at the earliest possible moment.

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# CHROMOMA OF THE FOREARM

A STUDY OF AN UNUSUAL TUMOR

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IN THE current (June) number of *Surgical Clinics of North America* (page 243), Cornett reports an unusual ulcerative lesion of the forearm. The history was briefly this: Twenty months before admission the patient's arm

was spiked in a ball game. The wound failed to heal but began gradually to increase in size. Repeated liberal biopsies were made and slides submitted to a number of pathologists of first rank who disagreed as to diagnosis. Not until after the death of the patient and the metastasis in the lymph-glands were examined was a general agreement to a diagnosis of carcinoma reached. To this diagnosis Dr. James Ewing agreed but added that the cells "are quite anaplastic and therefore lack some of the squamous-celled characteristics." Let us not lose sight of these words.

I have been struggling with this type of tumor for more than twenty years and the paper above quoted emboldens me to report several cases which involved the arm and presented many of the characteristic features of the patient reported by Cornett.

In my paper on "Melanoblastomas of the Foot" (*ANNALS OF SURGERY*,



FIG. 1.—Large ulcerous tumor of the forearm.

vol. lx, p. 88, 1914), I described several cases running a similar course. They began for the most part as nodules beneath the skin and by their growth destroyed the skin. These nodules extended gradually peripheral-



FIG. 2.—Slide from the nodules shown in the preceding picture.

wards, destroying the skin always by developing beneath it, but never stimulating the epithelium of the skin to participation. In a number of cases protuberant tumors were produced. These tumors grew slowly, always spread by way of the lymphatics, and in the more rapidly growing areas the cells predominated and produced alveolar-like arrangements (see Fig. 15 in the paper above

quoted). The metastases also not infrequently showed alveolar arrangement. They were influenced not in the least in their course, not even by amputation in cases where the growth was small and apparently of recent origin. This paper had to do only with the tumors of the foot. In these tumors of the foot the close association with pigment caused me to give them the name melanoblastoma with the sub-title of chromatophoroma. These tumors of the arm which ran a course similar to my foot tumors, I believe are parallel, likely identical with the case reported by Cornett above mentioned. The case reports follow.

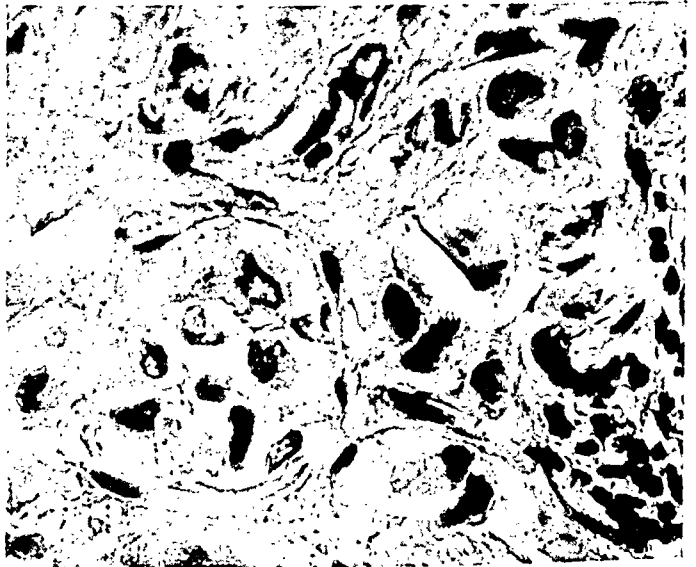


FIG. 3.—High power of the preceding showing large cells so arranged as to suggest nest formation.

CASE I.—Male, age thirty. Railway mail clerk. Two years ago he noticed a painless, round, firm tumor on the inner surface of his forearm. He had received a contusion in a railway accident some time previously. This tumor was removed but the wound did not heal and later a new tumor protruded from the wound. Now followed a long series of treatments.





separated with difficulty from tendons and nerves. Radium was used following the operation.

Four months after the second operation I saw the patient and obtained a photograph of the tumor (Fig. 4). An irregular bossilated mass protrudes from the wound. The nodulations are dense, elastic, do not bleed as readily as a carcinoma on manipulation and are quite insensitive to touch. The skin border is thickened, but macroscopically and on section is shown to be quite free from the growth beneath.

*Histology.*—As in the preceding case the masses of cells about the skin border are free from the epidermis. At the most advanced border the groups of cells were small

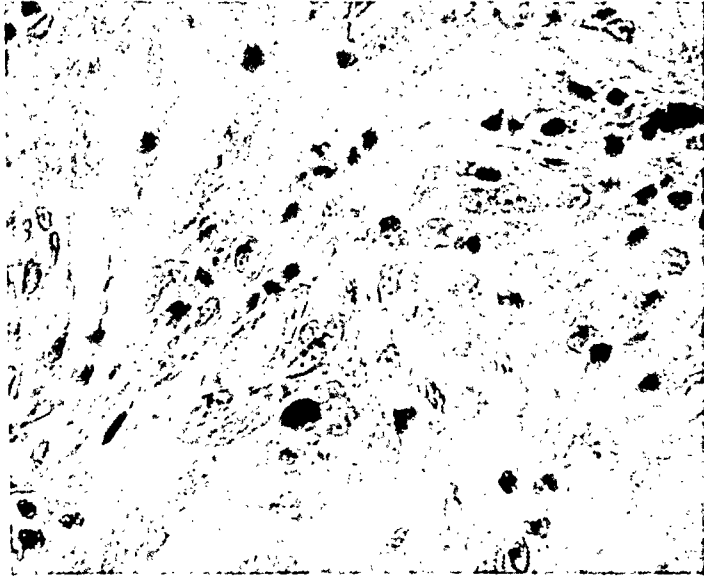


FIG. 6.—High power of the preceding showing the large cells like those in Fig. 3.

and were directed radiatingly downward toward the deeper tissue but showed nowhere any derivation from the epidermis. In some areas the cells are diffuse, in others they are arranged in groups showing an indefinite nest formation. The cells are characterized by large deeply staining nuclei with a considerable amount of protoplasm. This slide suggests the appearance of Cornett's Fig. 160. Even in this slide there are areas that suggest group arrangement (Figs. 5 and 6).

CASE III.—Female, age thirty-five. Two years before consulting her physician she noticed a painless lump the size of a hickory nut just beneath the skin of the forearm. It was quite painless. The tumor was removed but the wound never healed. The tissue was sent to this laboratory for examination. A diagnosis of a chronic reactive process was made.

The wound having failed to heal, the patient appeared in person. The tumor now appeared as in the photo (Fig. 7). The affected area was widely excised.

*Histology.*—The picture is as in the preceding: groups of cells free from the skin and invading the surrounding connective tissue. Smaller cells with deeply staining nuclei dominate the field, but here and there larger cells with granular nuclei may be seen (Fig. 8). It appears that it is these cells that travel to the neighboring lymph-glands.

#### SUMMARY

These tumors of the arm begin as nodules beneath the skin and apparently free from it. They gradually destroy the skin and continue to spread. The skin is destroyed by them as they advance but they are at no time associated with the skin. The ulceration continues to destroy the surrounding soft parts, in one of my cases exposing both bones of the forearm. They are never painful.

Histologically they begin as irregularly distributed cells beneath the skin forming more or less horizontal lines to the skin. In the various parts of the tumor the degree of fibrous tissue formation varies. Everywhere there is the same cellular arrangement. When the smaller cells dominate the process

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may be mistaken for a reactive one. In the older tumors the larger type predominate. They always metastasize by way of the lymphatics. In the more rapidly growing tumors a cell nest arrangement is common, but in the very slowly growing ones the lymph-glands may be almost entirely fibrous. By slowly growing I would include those in which the gland has been enlarged for some three to seven years.

*Discussion.*—My hypothesis is that these tumors are derived from the chromatophore cells. In the earliest part of the tumor the cells are arranged like the chromatophore cells and they look like chromatophore cells.

These arm tumors are free from pigment. This does not mitigate against their being chromatophores. In the foot sometimes they do bear pigment. Recent researches seem to have absolved the chromatophores from the manufacture of pigment and ascribe to them the function of absorbing pigment.

When one tries to decide the purpose of the chromatophores one is struck by the fact that they are found chiefly about blood-vessels. In teased specimens they resemble very closely the clasmocytes of Ranvier. From studies in wound healing I am disposed to conclude that their chief purpose is to aid in repair, particularly to form new vessels. I suspect they may aid in the repair of epithelial surfaces and that their function, in other words, is chiefly a reparative one.

I believe an extended study will convince anyone that the tumors in question are derived from these cells. Tumors derived from them are slowly growing, fibrous tissue producing tumors, often of exceedingly slow growth.



FIG. 7.—Early recurrence in Case III showing the old scar with the early appearance of an ulcer.

It is only when they do grow rapidly that the cellular elements predominate and alveolar arrangements are seen. In melanomas frequently the metastatic nodules form a distinct alveolar arrangement while the parent tumor is of a different structure. These are much more rapidly growing tumors.

These tumors in question differ from melanomas in their clinical aspects. They are more destructive locally, are more slowly growing and metastases are not formed so extensively and never metastasize by way of blood stream.

It is confusing that the name chromatophores should have been applied to these cells. It is merely expressive of a former theory as to their nature.

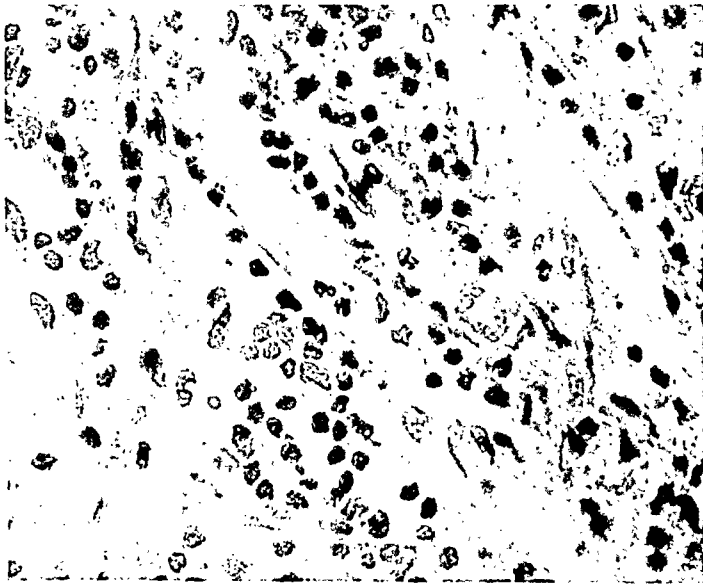


FIG. 8.—High power photograph of a slide from the ulcer area.

Studied in wound healing they suggest very much the clasmotocytes of Ranvier as one sees them in reactive processes of the peritoneum. They likely are as ready to pick up anything (lampblack, vermillion) as chromatin. Since we have this word it would seem to lessen the evil by calling these tumors chromatomas. So long as we remember that they have only a very remote association with

chromatin the word serves very well. When one studies these tumors in the foot one sees that the pigment in the primary tumors is lost in the metastasis, even in the more cellular. In my previous paper (following Ribbert) I was wrong in ascribing a close association with melanomas. It is possible that the melanin in pigmented warts may start off the chromatophores, but once started they manifest their own characteristics as is manifest by their course.

The older among the readers will remember what a neat little plastic operation in philology Waldeyer performed when he changed the cumbersome word *neurondendron* into the simple "neuron". If an equally weighty personage will perform a like operation on the cumbersome *chromatophoroma* and make it simply *chroma*, we will have a convenient word not too lacking in euphony. Of course it will be meaningless, if not altogether misleading, but since students no longer learn Greek, that fact is not likely to cause pain or confusion.

*Conclusions.*—Chromatophores are capable of producing a slowly growing tumor or ulcer that is characterized by slow growth, metastasizing by way of the lymphatics and proceeding relentlessly to a fatal issue.

That they at no time are associated with epithelial elements though they resemble very much anaplastic epithelial cells.

## FORMATION OF RADIUS CONGENITALLY ABSENT\*

CONDITION SEVEN YEARS AFTER IMPLANTATION OF BONE GRAFT

By FRED H. ALBEE, M.D.

OF NEW YORK, N. Y.

IN ALL bone-grafting operations, adequate function and prevention or correction of deformity are the prime desire of both surgeon and patient. The late end results are particularly interesting in these cases, because they illustrate so graphically the remarkable ability of the autogenous graft to strengthen with use and stress, and to act as a corrective agent.

Recently, while attending the meeting of the American Orthopedic Association in California, it was my good fortune to meet a patient who had come to me seven years ago, at the age of twelve, with congenital absence of both radii, and both thumbs. At that time the ulnæ were markedly bowed, and the hands turned inward (Figs. 1 and 2). A graft was taken from the tibia and its wedge-shaped ends mortised into properly prepared



FIG. 1.—Congenital absence of radius. Note bowing because of absence of radii; also absence of thumbs.

carpus below and the shaft of the ulna above (Fig. 3). A similar operation was later performed on the left arm. After the graft had thoroughly united with the carpus and ulna, an osteotomy was done on each ulna to correct the marked ulnar deviation (Fig. 4). It was advisable to produce over-correction as shown in the X-ray.

Recovery was uneventful and I had not seen the patient since four months after operation, when X-rays showed good union and considerable increase

\* Submitted for publication September 27, 1927.

in the diameter of the graft (Fig. 5). At that time the patient could lift weights (Fig. 6) which was not possible before operation because the wrists were flail, owing to the absence of the radius, which is the important bone in the wrist-joint. When the radius is absent, the hand pivots without control on the end of the ulna.

When I met the patient this summer in California, she had just come in from a tennis tournament in which she was one of the semi-finalists. A

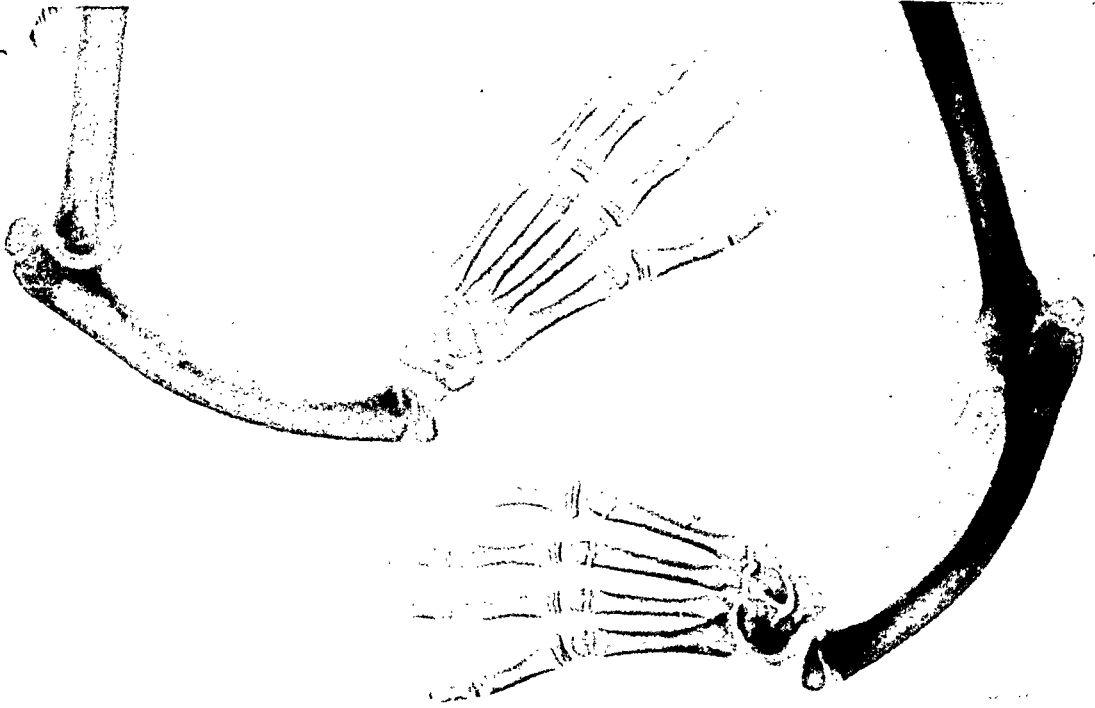


FIG. 2.—Pre-operative X-ray.

junior at college, she drives her own car, rides horseback, and devotes much of her leisure to painting. The ease with which she uses her arm, the degree of activity to which she submits it without fatigue, and the lack of awkwardness suggest a normal arm, and bear striking evidence to the possibilities of reconstruction surgery.

Figure 7 is an X-ray taken in June, 1927. Considerable correction of the bowing, which externally is not at all evident to the casual observer, and marked proliferation of the graft will be noted when compared with the earlier X-rays.

Congenital absence of the radius is rare. The author has seen ten cases and operated on three in the last ten years. Three cases are at present awaiting operation. The anomaly is reported as being more often unilateral than bilateral, and usually right-sided. In two of the author's operated cases, however, the condition was bilateral. In such cases it is advisable to operate on the right arm first.

If the child is very young when brought to the surgeon, it is advisable to wait until he is three years old before operating.

# FORMATION OF RADIUS CONGENITALLY ABSENT

FIG. 3.—Post-operative X-ray, December, 1920, showing graft in situ.

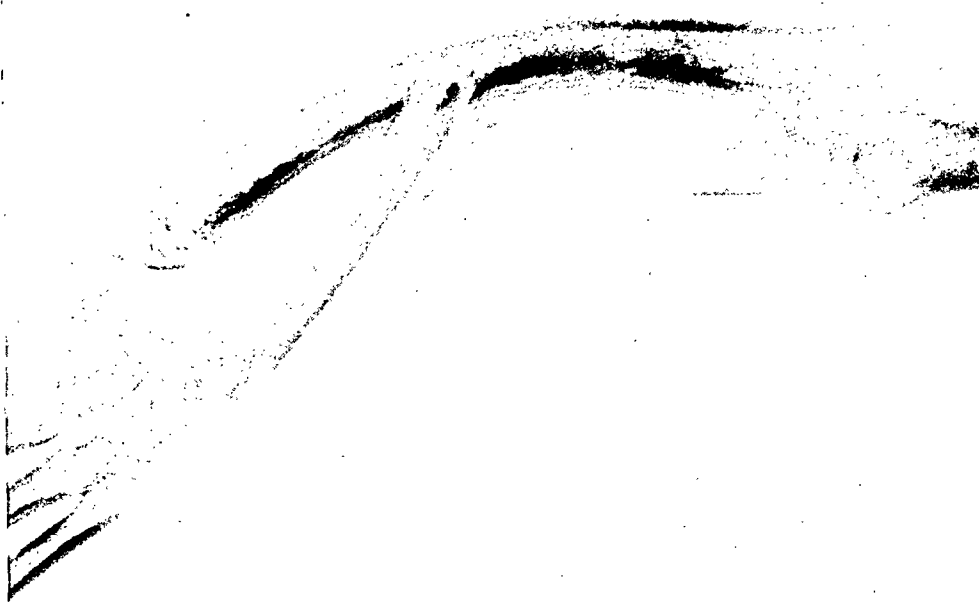
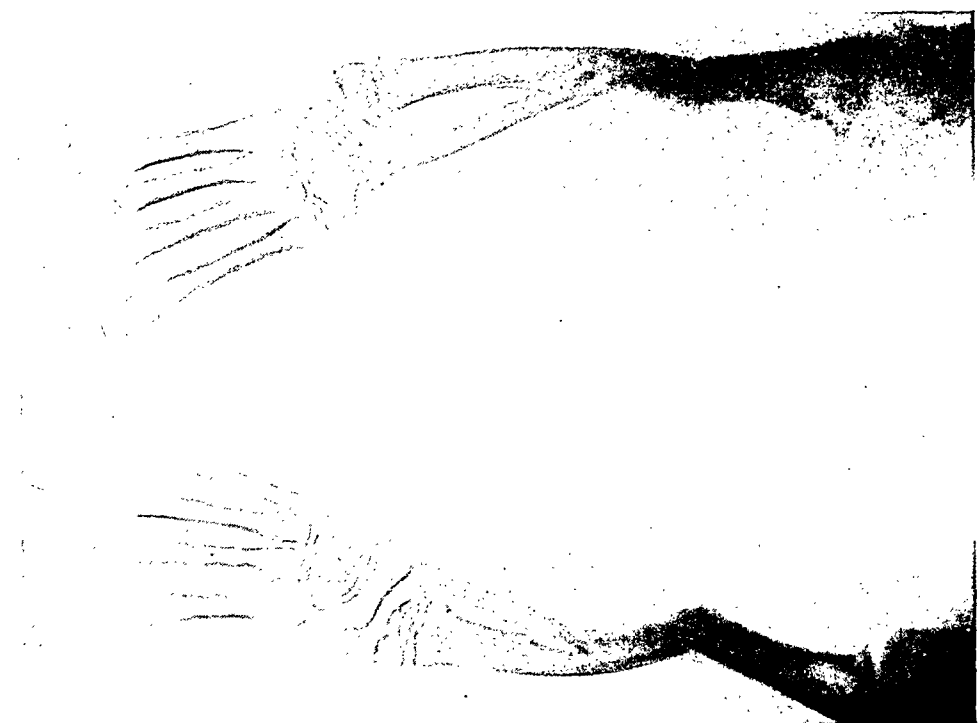


FIG. 4.—Post-operative X-rays, January, 1921. Note osteotomy to correct ulnar bowing.



FRED H. ALBEE

The second bilateral case was brought to the author when the child was seven weeks old. There was marked bowing of both ulnæ (Fig. 8). In

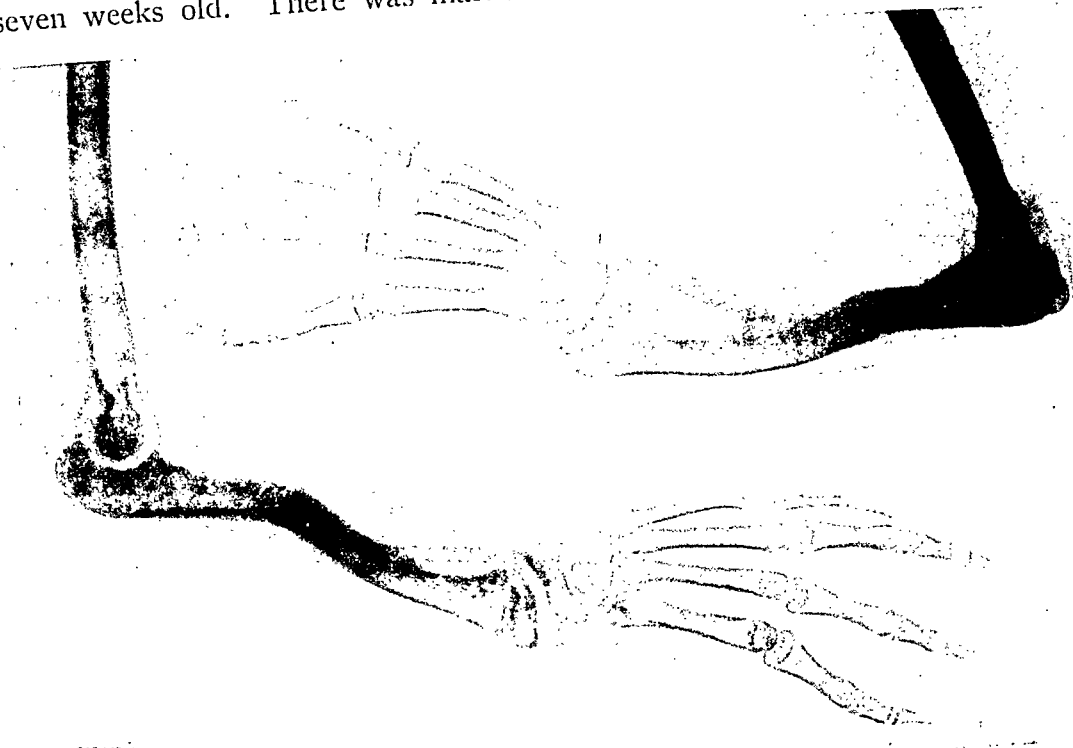


FIG. 5.—Post-operative X-ray, several months later.

March, 1927, when the child was three years old, a tibial graft was placed in the right arm. After the case was removed a brace was applied, a wise



FIG. 6.—Post-operative still. Patient able to lift weights, and uses pencil between fingers.

precaution in very young children, to protect the graft until it becomes thoroughly strong. The union in this case is excellent. The child evidenced his pleasure when last he came to the office by presenting me with his teddy bear and asking me to "put a new radius bone in its arm."

Although it is usually preferable to mortise the graft into the shaft of the ulna, the upper end of the graft may be

placed between the muscle planes of the forearm in the region where the upper end of the radius should be situated. This was done in Case II.

In one case, because of congenital absence of the carpus, the graft was



# FORMATION OF RADIUS CONGENITALLY ABSENT

FIG. 7.—Post-operative X-ray, Case I, July, 1927. Graft has proliferated, and bowing of ulna is corrected.



FIG. 8.—Congenital absence of radius with marked deformity in child of three. (Case II.)

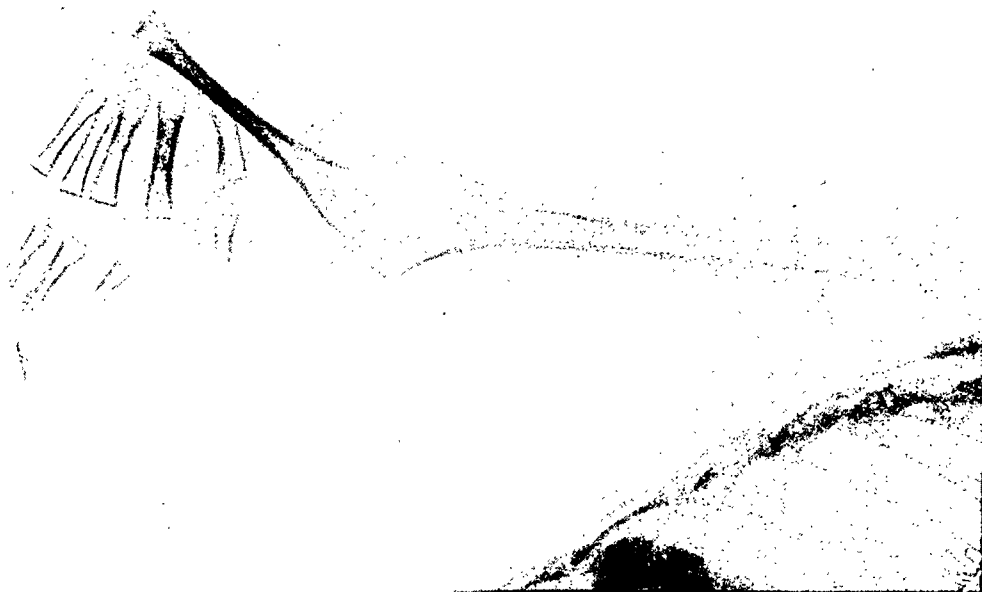
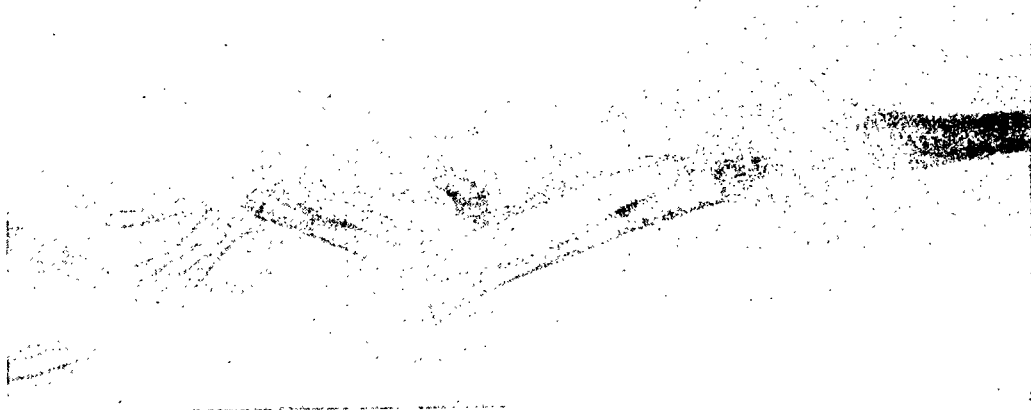


FIG. 9.—X-ray of same case, three months after operation. Graft in place. Position of hand much improved.



mortised into the first metacarpal at the distal end. The proximal end was placed between the muscles on the radial side of the forearm instead of being mortised into the ulna. At the time of its insertion, the graft was under considerable lateral tension because of the marked tendency of the hand to seek an angular posture with the forearm toward the radial side.

As a theoretical consideration, at least, it would seem that placing the upper end of the graft between the muscle planes affords a certain advantage, as it will allow the graft to be pulled down slightly during growth, thus taking advantage of epiphyseal growth at both ends of the ulna, and minimizing distortion during growth, which occasionally occurs owing to the epiphysis at the carpus being pushed out. On the other hand, stability may be slightly jeopardized by this procedure, and because of this latter consideration it is not adopted routinely.

In one of our early cases, reported in the author's "Orthopedic and Reconstruction Surgery," the first graft was not mortised at either end, but merely placed between the muscle planes, with contact with the scaphoid at the distal end. This graft proved unsatisfactory because it did not afford sufficient mechanical support. A second graft was inserted five months later, and firmly mortised at each end by the author's inlay technic. This united firmly and afforded excellent support to the wrist. The X-rays taken six months after operation showed increase in strength and dimensions of the graft, as in the case now reported. (See Fig. 615, p. 905, "Orthopedic and Reconstruction Surgery.") The case was a brilliant success.

## THE USE OF A FLEXED PLASTER SPICA CASE IN THE TREATMENT OF HIP FRACTURES

By GEORGE ALBERT MOORE, M.D.

OF BROCKTON, MASS.

A REVIEW of recent progress in the treatment of hip fractures shows that there has been a gradually increasing interest in this subject during the past twenty-five years. This has resulted in a clearer understanding of the underlying pathology of hip fractures and in the development of new and more efficient methods of treatment. There has also resulted a somewhat lower mortality and higher percentage of good functional end results.

These facts have been well brought out by Faltin<sup>1</sup> and Lindgren,<sup>2</sup> who published in 1924 an exhaustive compilation and summary of the literature on the subject.

Faltin reviewed the anatomy and pathology of the various types of lesions encountered in these fractures and discussed their various possible methods of treatment. He drew attention to the lack of recent investigation of the circulation of the hip-joint, and stated that

the studies of Lang,<sup>3</sup> Delidoff<sup>4</sup> and Basset<sup>5</sup> each have shown conclusively that the blood supply to the neck of the femur is in two synovial folds which extend along the anterior surface of the neck. The nutrient arteries enter the neck at its narrowest part, near the middle, which on account of its structure and poor blood supply not only is a frequent site of fracture, but often



FIG. 1.—No. 1121. Anterior view of flexed spica case. Note inverted position of leg and foot.

unites unsatisfactorily. Faltin also suggested that the absence of periosteum covering the neck of the femur and the resulting slow formation of callus which is endostial in origin in fractures in that region might be another factor in causing delay or lack of union.

According to Basset the blood supply to the head of the femur through the ligamentum teres is sufficient to prevent necrosis of the head after fracture, even in old people, and is a distinct aid in promoting bony union

when suitable treatment is carried out.

Faltin argued that the high mortality following hip fractures so often encountered was due in the majority of cases to complications arising from the protracted bed treatment used in conjunction with many modern methods of treatment.

Regarding the most satisfactory method of reduction of fractures of the femoral neck, there were still divergent views held by different writers. Lucas-Championniere,<sup>6</sup> Kocher,<sup>7</sup> Böhrringer,<sup>8</sup> Anschutz<sup>9</sup> and others advised that impactions of the broken fragments should not be disturbed except in cases of marked deformity, as

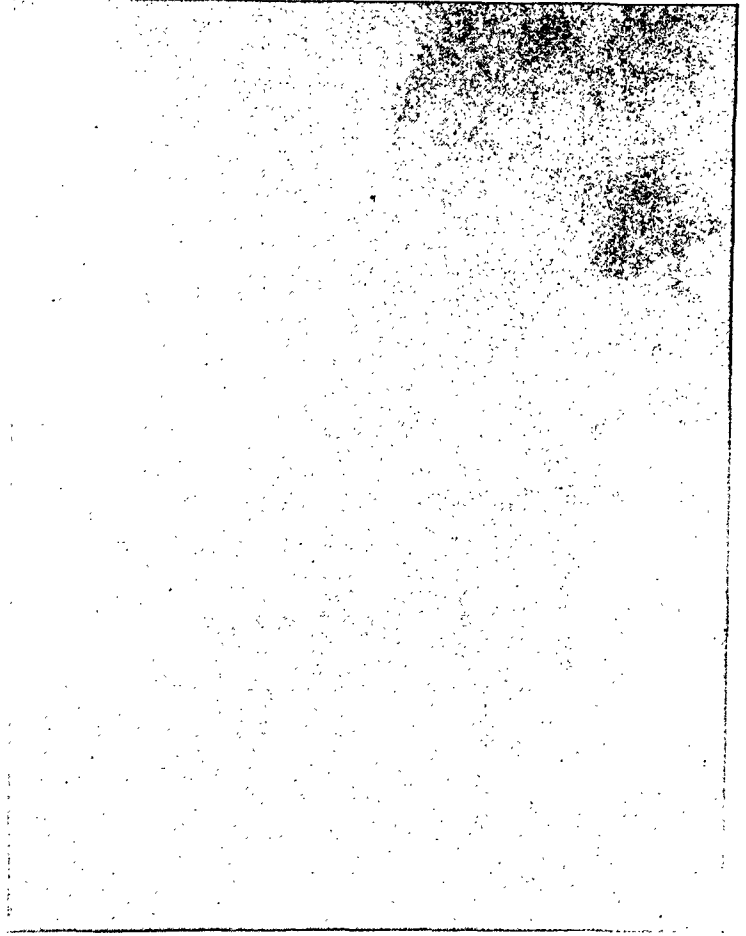
FIGS. 1 and 2.—No. 1121. Röntgenogram after reduction. Bony union and excellent function resulted. Age seventy-six.

their presence appeared to have some beneficial effects in promoting union. Bardenheuer,<sup>10</sup> Hoffa,<sup>11</sup> Whitman,<sup>12</sup> Maxwell,<sup>13</sup> Lorenz,<sup>14</sup> Nicolaysen,<sup>15</sup> Ruth,<sup>16</sup> Judet,<sup>17</sup> Waldenstrom<sup>18</sup> and Matti,<sup>19</sup> on the contrary, broke up and reduced nearly all fractures of the neck of the femur with satisfactory results. The value of Cotton's<sup>20</sup> plan of artificial impaction was difficult to estimate as Cotton combines his method with Whitman's abduction case.

Faltin favored as a general rule reduction of all fractures of the neck except in the very feeble and in those with slight deformity, since impactions were not necessarily permanent and might break loose later on, thus causing prolonged disability.

## FLEXED PLASTER SPICA CASE FOR HIP FRACTURES

The so-called "bloodless methods of treatment" of hip fractures which result favorably were discussed impartially by Faltin. Lucas-Championniere advocated a method which consists in "massage, early mobilization and non-protracted stay in bed" in all cases of hip fractures. As a result of his system of treatment, he has his patients up and walking about in eight to fifteen days after injury. He has reported many excellent results, but has gained few adherents to the method he uses. Of the "traction" methods, those of Phillips, Maxwell and Ruth<sup>21</sup>, Bardenheuer and Judet seemed most worthy of consideration. The general principles of these methods are similar, longitudinal traction on the injured leg and lateral traction on the hip to put the capsular ligaments on stretch, thus holding the fragments in apposition. Elaborate detail was required in their application and painstaking care necessitated throughout treatment. Excellent results have been reported, especially by Ruth and Bardenheuer. Whitman's abduction method of treatment had the disadvantages of a prolonged anæsthesia, reduction trauma, a heavy bandage and strong abduction position which prevented the patient from walking.



FIGS. 1 and 2.—No. 1121. Röntgenogram of hips before reduction.

The various splint and bandage methods of treatment all depended for their effectiveness upon the principles of the Thomas splint and all attempted to transfer the strain of weight bearing from the foot and leg to the tuberosity of the ischium. Some, as the Thomas long hip splint, Maseland<sup>22</sup> splint and Jones<sup>23</sup> abduction frame were intended for bed treatment, others were devised for ambulatory cases and combine abduction and traction of the injured leg. Of the latter methods, those of Bradford,<sup>24</sup> Borghi-Rossi,<sup>25</sup> Bender<sup>26</sup> and Haslauer,<sup>27</sup> which attempted to get the patients on their feet as soon as possible, seemed of real value.

Lindgren attempted to evaluate the end results of the treatment of hip fractures reported by several writers and treated by various methods and also

gave a detailed account of his investigations of 95 cases cared for at the surgical clinic in Upsala. He stated that the reports in the literature of the careful, painstaking study of the end results of the treatment of hip fractures were very scarce and gave this fact as one of the important reasons for the general slow adoption of active methods of treatment. For example, Ridlon<sup>28</sup> reported twenty good results out of thirty-five cases having no systematic form of treatment, in order to emphasize the belief that an undisturbed solidifying process during a sufficiently long period was one of the most



FIG. 2.—No. 1121. Lateral view of flexed spica.

fundamental factors in securing a proper union in fractures of the neck of the femur. Lindgren, however, believed that no general conclusions could be drawn from Ridlon's statistics as there was no classification of the fractures. Lindgren also questioned for various reasons the value of conclusions drawn from reports by Campbell,<sup>29</sup> Cotton,<sup>30</sup> Basset and Moore.<sup>31</sup>

His own figures were compiled from 49 cases of medial fracture of the neck of the femur and 46 lateral fractures. Thirty-one were treated by conservative methods

with a death rate of 26 per cent.; and 64 were treated by active methods with a death rate of 20 per cent. The so-called conservative methods employed were: 1. Bed confinement without fixation of the injured hip. 2. Apposition of the broken fragments and fixation with sand-bags. 3. Indirect extension with abduction under seven or eight kilograms. Of the medial fracture cases treated in this manner all but one resulted badly, the lateral fracture cases, however, obtained a high percentage of satisfactory results.

The active methods of treatment consisted in immediate direct extension of the impacted fragment with Schmerz tongs in a few cases and abduction methods in a large number of the series. In cases treated with the Schmerz tongs a half plaster case was applied at the end of three to five weeks. The abduction method consisted in reduction of the fracture under anæst-

## FLEXED PLASTER SPICA CASE FOR HIP FRACTURES

thetia, the leg being then put in a half plaster-of-Paris case, from the nipple line to the malleoli with the knee in slight flexion. In a few cases a circular spica case was used. Results with Schmerz tongs were unsatisfactory, and much poorer than when the abduction method was used. Of 26 patients treated in abduction, 10 had true bony union. Of the thirty patients with lateral fractures, on the other hand, examined one year or more after treatment was begun, all had obtained bony union. Disability in these cases was due to faulty position of the fragments.

Lindgren concluded that cases of fracture of the neck of the femur have fairly good chances of union if the broken fragments are placed in perfect apposition and retained in this position during the period of callus formation. They should be allowed to become firmly united by proper protection from various mechanical strains during a long period of time. He considered that medial fractures were apt to be followed by defective union and were a most serious problem as regards treatment. Bony union could be obtained in a large percentage of cases, however, if utilization and encouragement of the healing propensities were practiced.

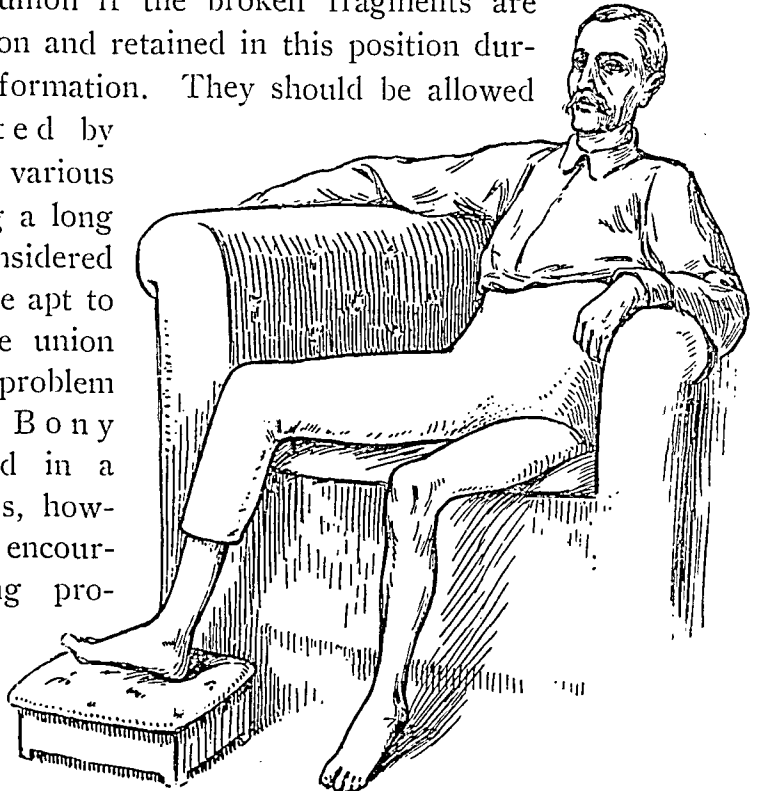


FIG. 3.—Case described by Judet: *Bull. d'l'Acad. d. Med.*, 1921, vol. lxxxv, p. 63.

So discouraging have been the results of treatment of medial fractures in the past that many writers, notably Cooper,<sup>32</sup> Kocher, Anschutz, Delbet,<sup>33</sup> Robineau and Contremoulins,<sup>34</sup> Judet, Konig,<sup>35</sup> Bonn<sup>36</sup> and others have advised early operation in such cases with reduction and bone pegging or excision of the head and a reconstruction of the neck of the femur.

In recent years, a number of writers such as Cotton, Ruth, Whitman, Portwich,<sup>37</sup> Fromme<sup>38</sup> and others have reported many cases of bony union following treatment of medial fractures of the neck of the femur. On the whole, therefore, it is evident that modern methods of treatment of hip fractures including exact apposition of the fragments, prolonged fixation and protection of the injured hip for several months from strains, and weight bearing has resulted in an increase in the percentage of cases with bony union and good functional results.

The therapeutic value of posture in the treatment of many diseases is practically universally recognized. The prone position of Schintzler for

acute dilatation of the stomach is quite generally accepted as an effective means of relieving this condition. Elevating the head of the bed as an adjunct to the management of patients with decompensated hearts, acute pulmonary conditions and diffuse peritonitis are therapeutic methods which have been in common practice for well over a century.

In recent literature on hip fractures frequent reference to the value of posture as an adjunct to the treatment of this injury is found. Whitman raises the head of the bed and turns the patient on each side and on the face to promote better circulation and prevent hypostatic pneumonia. Dorrance



FIG. 4.—No. 1493. Application of flexed spica, using "spica box."

and Murphy, who are using the Whitman abduction method, get patients out of doors in a wheel chair a few hours each day after the third week of treatment. Campbell and Portwich mention the use of a chair in which patients treated by the Whitman straight spica case may sit.

Practically all writers on hip fractures in the past have concurred in the opinion that dorsal recumbency was a necessary adjunct to the successful management of these patients. A few cases have been reported in which a straight hip spica case or Thomas hip splint and crutches have been used throughout treatment with good results. These methods, however, are adaptable to the strong, robust individual, but are quite unsuited to the aged, debilitated patient so frequently the victim of a hip fracture.

For several years I have been interested in various problems involved in the most satisfactory management of hip fracture cases and in 1916 suggested a method of treatment in which the fracture was reduced and the injured leg was placed in a position of abduction, flexion and internal rotation or approximately in a normal sitting position, and so held by a plaster spica case during the period of healing. (See Figs. 1 and 2.) In this way patients could be up in a wheel chair every day throughout the fixation period of their treatment. The results were encouraging both as regards the physical condition of the patient while undergoing treatment and the ultimate function of the injured hip. In 1921, I published a second article reporting a series of 42 cases with the so-called "flexed spica". In this series of cases there were 25 which recovered with good functional results, 2 died during treatment, 11 recovered with considerable disability, and 4 were lost trace of.

In a series of cases by Campbell in 1919, he mentioned applying a plaster



## FLEXED PLASTER SPICA CASE FOR HIP FRACTURES

case in three cases with the leg in abduction, flexion and internal rotation to "facilitate early sitting position". Judet, of Paris, in 1921 reported the use of a case identical to that which I have used. (See Fig. 3.)

My results since 1921 have continued to be satisfactory and seem to warrant a detailed description of the method as it is now being used.

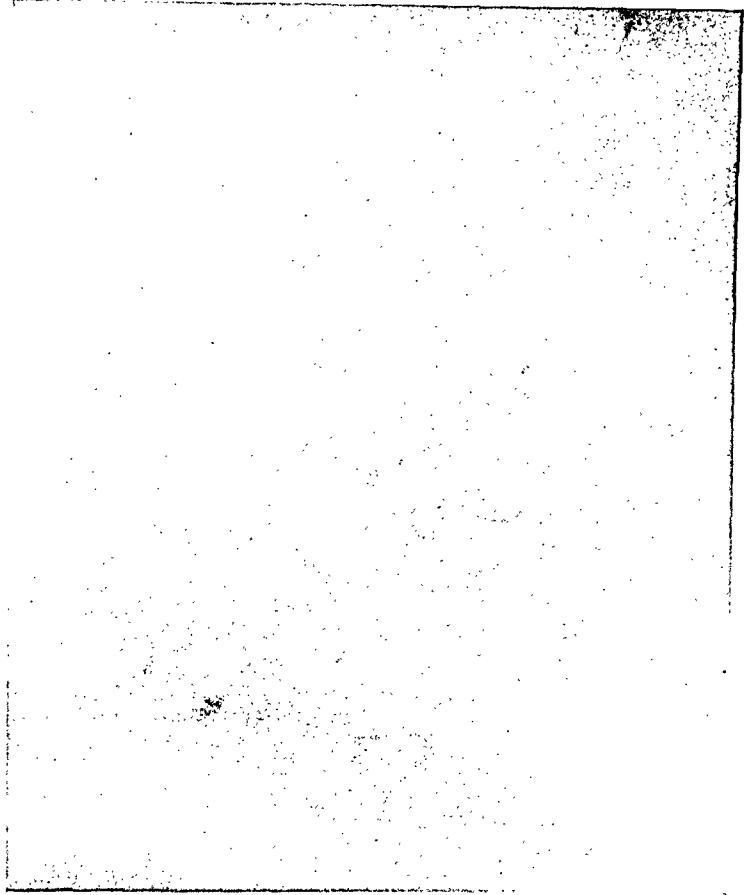
Ether or morphine and scopolamine anæsthesia was generally employed until recently for reduction of the fracture and application of the case. In fourteen of my late cases, spinal anæsthesia was substituted. Manipulation of the fragments and maintenance of the fixed position during the application of the case are carried out more easily with this anæsthetic than with ether owing to the more complete relaxation of the muscles. Post-anæsthetic vomiting did not occur, and the patients were able to take food earlier than when ether was administered. Therefore, at least, in the case of feeble patients, spinal anæsthesia appears to offer certain advantages.

It is surprising to find but few references in the literature to the

employment of spinal anæsthesia in the reduction of hip fractures. Adams,<sup>39</sup> in 1921, reported its use in five cases, Robineau and Contremoulins refer to it in their cases of hip fracture requiring operative treatment. Portwich also mentions it but does not state how extensively he uses it.

I now use in reduction of these fractures a modification of the method described by Robineau and Contremoulins. Their method briefly described consists in a double fulcrum in the groin, longitudinal traction on both legs and abduction and inward rotation of the injured leg, thus stretching the capsule of the joint and forcing the fragments into close apposition. There would seem to be no question but that a more accurate apposition of the fragments can be obtained by this method than by the older methods of reduction.

Instead of using double perineal supports or fulcrums described by



FIGS. 4 and 5.—No. 1493. Fracture reduced. Case applied.

Robineau and Contremoulins, I have bandaged the patient firmly to the sacral support of a spica board; then after the usual manipulation of the fractured hip to separate the fragments of bone and to release any interposing tissues between the fragments, lateral traction on the hip has been exerted while an assistant made traction in the longitudinal direction and forcibly inverted the leg. The position of the fragments is then verified by antero-

posterior and stereoscopic X-ray plates.

After the reduction is completed an assistant holds the uninjured leg with the knee and hip flexed at right angles and the thigh abducted as far as possible. This serves partly as a counter-traction to the force exerted upon the injured leg during the application of the case. While longitudinal traction is still maintained on the injured leg, the position of the leg is gradually changed until the knee is flexed at right angles and the thigh flexed at right angles with the body. During this change in position, care is taken to maintain a position of forced internal rotation of the leg. The longitudinal traction on the



FIGS. 4 and 5.—No. 1493. Röntgenogram before reduction.

injured hip has now been changed to practically a vertical traction. The leg is now abducted as far as possible and is maintained in this position during the application of the case.

I have demonstrated that the above-described position (Figs. 4 and 5) utilizes the capsular ligaments and muscles about the hip-joint, which maintain apposition of the fragments of the neck of the femur after reduction has been accomplished. Abduction of the hip puts the anterior ligaments of the capsule and abductor group of muscles about the joint on stretch. Forced internal rotation of the thigh overcomes the eversion of the leg resulting

## FLEXED PLASTER SPICA CASE FOR HIP FRACTURES

from the action of the obturator externus and the short external rotator muscles. (Figs 6 and 7.) Flexion of the hip puts the gluteus maximus and medius on stretch, thus forming a strong hammock, supporting the great trochanter and preventing backward displacement or eversion of the thigh. (Fig. 8.)

Upward and outward traction, abduction and internal rotation of the injured leg are maintained by an assistant while a single plaster spica bandage is applied from the nipple line of the chest to the calf of the injured leg. After this portion, if the case has set, all traction is released and the remaining part of the case from the calf to the toes is applied. It is necessary to reinforce the case heavily in the groin to avoid breaking in this region. Considerable care is also required in applying the case about the buttocks to withstand the pressure on this portion of the case in sitting.



FIG. 5.—No. 1493. Flexed spica completed.

During the first few years of using this method, the bandage was carried down to the calf of the leg. Since marked swelling of the leg and foot often resulted, it has seemed better to advise extension of the bandage to the toes.

The day following the application of the case, the patient sits up on the side of the bed with the back support and feet on a stool. Each day thereafter as long as the case is worn the patient sits on the side of the bed with feet on a stool or is out of bed in a chair. Patients are thus able to wait upon themselves to a considerable extent and busy themselves in many ways that they would be unable to do if they were in bed. They require a minimum of nursing care. Bathing and care of the back before getting up in a chair in the morning, and assistance in returning to bed at night constitute the more important duties of the nurse.

It is a rare occurrence for the patient to remain in the hospital throughout treatment with the flexed spica. Most patients are discharged from the hospital to their homes two or three weeks after the application of the case to be cared for by members of their family or by a trained nurse. To the family of moderate means, the reduction in hospital bills, by this method of treatment, is an appreciable saving.

In the early cases of medial fracture in my series, the case was removed at the end of eight weeks. In some aged patients the results were unsatisfactory owing to fibrous or weak bony union.

The period of fixation should be at least twelve weeks in medial fractures

and in old, feeble patients, sixteen weeks if the treatment is well borne. After the removal of the case, from two to six weeks should be spent in bed, gradually regaining the use of the leg. Active exercise should be attempted first, later followed by passive motions and massage.

Any strain upon the injured hip should be prevented, on getting up, by the use of a walking brace of the Jones type, the type described by Dorrance and Murphy or some similar protective apparatus.

In certain cases in which a firm bony union is known to exist, weight bearing can be safely undertaken at the end of eight months; but in the majority of patients past middle life with a medial fracture, full weight bearing cannot be undertaken safely for at least a year from the beginning of treatment.

Four illustrative case reports are offered:

1. Moore Hospital, No. 111, male, aged seventy-five, November 24, 1917. About twenty-four hours before admission he slipped on the ice and fell, injuring his right hip. He was still in considerable shock and having involuntary urine. A rather feeble, shaky old man, blood-pressure 160-90 with nothing remarkable in his general physical examination. A slight trace of albumen

FIG. 6.—The usual position of the distal fragment in a loose medial fracture, resulting from the action of the glutei, obturator externus and short external rotators of the thigh.

and a few casts in his urine. His right leg was everted 45 degrees, shortened  $1\frac{1}{2}$  inches; he was unable to raise it from the bed and there was a relaxation of the ilio-trochanteric band of fascia. The X-rays showed an impacted medial fracture of the neck. On November 29, under gas oxygen, the fracture was reduced and a "flexed spica" case applied. He was up in a wheel chair daily until the case was removed February 19, 1918. After the removal of the case he was kept in bed for three weeks and given massage, active and then passive motion. Gradually he got about and September 15, 1918, he was walking with one cane without limp or pain in the injured hip.

2. Moore Hospital, No. 1026, male, aged fifty-nine, July 25, 1921. Three hours before admission he fell from a load of hay to the ground, striking on his left hip. He was a strong, robust man, suffering severe pain in the region of the left

## FLEXED PLASTER SPICA CASE FOR HIP FRACTURES

hip. The pain was markedly increased on motion of the hip. He had no eversion or shortening of the left leg. X-rays showed a lateral fracture of the hip without displacement. A "flexed spica" case was applied under ether. August 14, 1921, he was discharged to his home, having been up in a chair daily since the case was applied. October 1, 1921, case was removed, he was kept in bed two weeks thereafter. Then got up on crutches and gradually began weight bearing on the injured leg. January 15, 1922, walking without support or limp.

3. Moore Hospital, No. 1672, female, aged eighty-six, August 8, 1922. July 25, 1922, patient was hit by an auto, which pushed her down, injuring the right hip. She had been in bed with the head raised for two weeks and a hopeless prognosis given

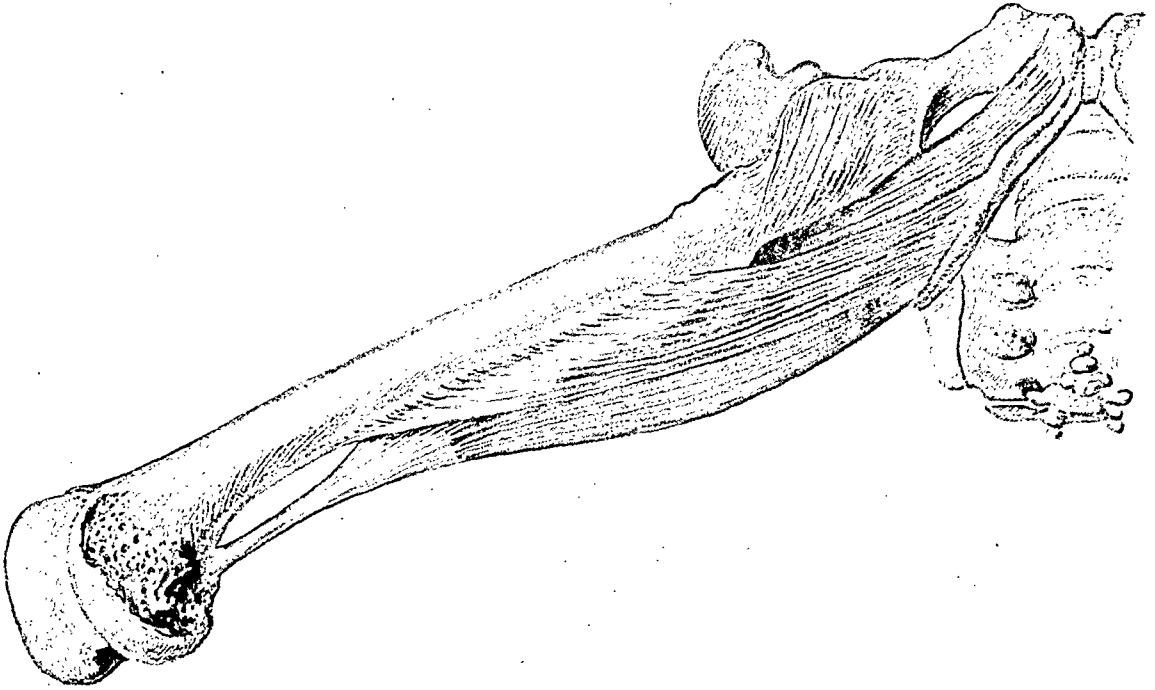


FIG. 7.—Showing the action of the adductors and capsular ligaments in the dissected subject in holding the fragments in apposition, after reduction, in the flexion abduction and internal rotation position before applying the flexed spica case.

by the family physician. On examination she was found poorly nourished, feeble, shaky, had moderate cough, numerous râles in base of each lung, slightly cyanotic, pulse rapid, poor quality, intermittent, blood-pressure 110-60. X-rays showed impacted medial fracture neck of right femur. She was put upon a high back rest and stimulants administered. August 22, she had improved to such an extent that the fracture was reduced and a "flexed spica" case applied under spinal anaesthesia. She sat up on the edge of the bed and in a chair each day until the case was removed December 1, 1922, at that time X-rays showed excellent union. She was kept in bed the usual three weeks for massage and motion after the removal of the case and then gradually got up and about with crutches and a crutch splint. She was not seen again until September 15, 1923, at which time she was walking without crutches or cane and only had a slight limp.

4. Moore Hospital, No. 2608, male, aged fifty-three, February 6, 1925. A few hours before examination patient fell on the ice, injuring his right hip. He was in excellent physical condition except for the injury to the right hip and ankylosis of the right knee at 45 degrees flexion which resulted from an old injury. Complained of severe pain in the right hip, moderate eversion of the leg with about one inch shortening. X-rays show a lateral fracture with moderate displacement. The following day the fracture was reduced under spinal anaesthesia and a "flexed spica" case applied

with the knee in the ankylosed position. He was discharged to his home one week after the application of the case. On returning home he walked with crutches, got in and out of the wagon and did nearly all of his work about the farm. April 15, the case was removed and he walked about with crutches for a few weeks but soon discarded them. June 15, he was walking as well as before the injury.

#### SUMMARY

There is still considerable divergence of opinion among recent writers on hip fractures regarding the most satisfactory method of treating this

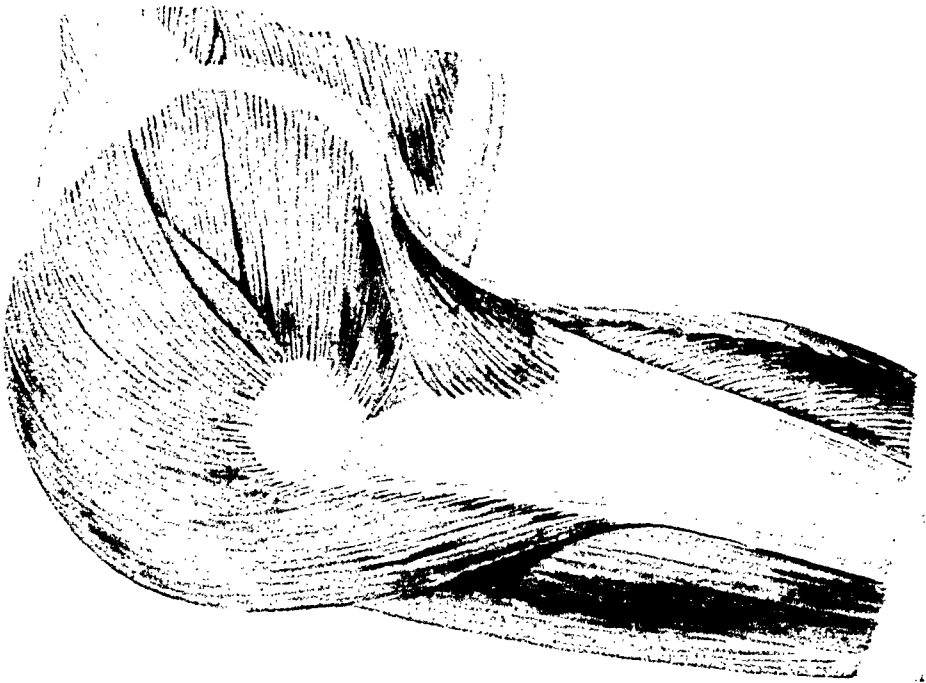


FIG. 8.—The glutei in the flexed position acting as a strong hammock back of the great trochanter.

injury. Active methods of treatment, including abduction, appear to be more generally accepted than any other.

The view expressed by many writers that medial fractures of the hip never unite by bony union is incorrect. The chief factors in delayed or non-union following medial fractures are injury to the blood supply to the fragments of bone, slow formation of callus which is endostial in origin, imperfect apposition and fixation of the fragments and too early weight bearing.

Posture is an important adjunct to the treatment of hip fractures in aged, feeble patients.

The "flexed spica" treatment of fractures of the hip allows patients to assume a sitting position during the period of repair of the fracture while the hip is fixed in position of flexion, abduction and internal rotation. This method of putting up hip fractures has proved remarkably satisfactory in a large series of cases. The details of its application are described.

# FLEXED PLASTER SPICA CASE FOR HIP FRACTURES

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# THE UNTOWARD EFFECTS OF NARCOTICS AND ANÆSTHETICS UPON ROBUST AND HANDICAPPED PATIENTS\*

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THE ideal anæsthetic is one causing the patient only slight discomfort, affording a depth of anæsthesia under which operative procedures can be carried on easily, and producing minimal injurious effects.

The short induction period of nitrous oxide and ethylene with almost no sensation of asphyxia contrasts rather strongly with the prolonged discomfort caused by ether. Nausea, so frequent after ether, is less common with ethylene or nitrous oxide, and when it does occur is of short duration. Post-operative pain, especially when there is an abdominal incision, is intensified by vomiting and, therefore, is worse following ether.

The muscular relaxation that permits of rapid work in the abdomen is more easily obtained with ether. Coöperation of the surgeon and anæsthetist when working with ethylene or nitrous oxide can diminish this advantage. Gentle handling of tissue, a few minutes' warning before upper belly manipulation, an incision that gives exposure without violent retraction enable an anæsthetist to provide adequate relaxation with ethylene. Nitrous oxide alone seldom will induce a depth of anæsthesia sufficient for laparotomy without some cyanosis.

Nitrous oxide and ethylene probably produce no direct injurious effect upon the lung. Pneumonia and bronchitis occur, but no more frequently than would be expected following operations under local anæsthesia. A large proportion of pulmonary complications are embolic in origin and, therefore, not attributable to anæsthesia. We are using ethylene on patients having pulmonary tuberculosis and bronchiectasis with no incidence as yet of acute inflammatory reaction. The number of pulmonary complications following ether is appreciable and in the debilitated is of sufficient frequency to be nearly prohibitive.

Intestinal stasis, paralytic ileus, and dilation of the stomach, although caused principally by operative manipulation, are in part due to anæsthesia. When ethylene is used exclusively, there is little gastric dilation. Post-operative distention is not frequent and is seldom severe. When ether is the anæsthetic, gastric lavage is a common necessity. The annoying thirst subsequent to ether, often unsatisfied because of gastric upsets, rarely occurs after ethylene or nitrous oxide for fluids usually can be taken in generous

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\* Read before the American Surgical Association, May 13, 1927.



amounts the day of operation. Miller (*Jour. Pharm. and Exper. Therap.*, 1926, vol. xxvii, p. 41), in demonstrating the effects of anæsthetics upon peristalsis and gastro-intestinal tone, supplies the explanation. During ether anæsthesia, peristaltic action is abolished and muscular tone is diminished. Recovery is slow and it is hours before normal activity is resumed. The tone of the stomach returns more slowly than that of the small intestine while the colon is frequently in a state of spastic contraction. Nitrous oxide does not alter peristalsis or muscle tone unless cyanosis develops when the peristaltic waves may be abolished or become tumultuous. Ethylene produces no change in gastro-intestinal activity either during or after anæsthesia.

Chloroform, ether, and nitrous oxide cause tissue changes. Cloudy swelling and granular degeneration are evident in heart, liver, and kidneys. Stander (*Am. Jour. Obst. and Gyn.*, 1926, vol. xii, p. 633) has found that anoxæmia alone causes degenerative changes in liver cells. Ethylene produces slight changes in liver while he finds no demonstrable lesions in the kidney. Studies made by Davis show slight œdema in kidneys.

During and after anæsthesia there are abnormal variations in the blood's acid-base balance. Leake and Hertzman (*Jour. A. M. A.*, 1924, vol. lxxxii, p. 1162), Stander (*Am. Jour. Obst. and Gyn.*, 1926, vol. xii, p. 633), and numerous others have reported these changes. Our findings agree with theirs. There is an increase in the hydrogen-ion concentration, a decrease in alkali reserve as measured by the carbon-dioxid combining power, an increase in sugar, an increase in lactic acid, and usually an increase in phosphates. Chloroform and ether produce the greatest change while that caused by nitrous oxide is inversely proportional to the percentage of oxygen. Ethylene causes the least change in any of these blood constituents.

The mechanism whereby these changes occur is still in doubt, yet some steps in the process are known. Stander (*Am. Jour. Obst. and Gyn.*, 1926, vol. xii, p. 633) and others have shown that anoxæmia produced by breathing an atmosphere of 7 per cent. oxygen lowers the carbon-dioxid combining power and raises the blood sugar. Evidently oxygen deficiency is a cause of acidosis. Ronzoni, Koechig, and Eaton (*Jour. Biol. Chem.*, 1924, vol. lxi, p. 465) find that the increase in lactic acid accounts for part of the increased hydrogen-ion concentration and the lowered alkali reserve. The increase in phosphate, according to Stehle and Bourne (*Jour. Biol. Chem.*, 1924, vol. lx, p. 17) comes from muscle as phosphoric acid and aids in lowering the pH of the blood. These findings would explain the acidosis following nitrous oxide when cyanosis occurs, but hardly accounts for that produced by ether and chloroform when the oxygen in the inspired mixture is adequate. Apparently one effect of anæsthesia upon metabolism is a slowing-up of oxidation. The cells are unable to utilize the oxygen carried to them. Lactic acid is not oxidized quickly to carbon-dioxid and water because the process is inhibited by the anæsthetic. An anoxæmia, therefore, exists, although the actual amount of oxygen in the blood is within normal limits.

Thalhimer and Raine have shown that acidosis interferes with carbo-

hydrate metabolism to such an extent that a patient in post-operative acidosis maintains an elevated blood sugar under doses of insulin that would cause violent insulin shock in a healthy individual. The acidosis then may account for the increase in sugar.

Clinically, we see these changes in the acid-base balance as post-operative acidosis. Ether and chloroform are the principal offenders. The vomiting that starts immediately after operation continues because of the acidosis.

The further loss of fluid and the lack of food make a vicious cycle.

The danger of chloroform and ether in diabetes is too well realized to need repetition.

In robust individuals minor changes in acid-base balance are quickly compensated, but, in the debilitated, acidosis may mean the difference between recovery and death. Ethylene, clinically and experimentally, has proved the least injurious, for there is less actual and inhibitory anoxæmia.

Ether, chloroform, nitrous oxide, and ethylene diminish the oxygen-carrying power of the blood. Oxygen-carrying power, measured by the Van Slyke method,

is one of the most accurate means of determining hæmoglobin. There is, therefore, a destruction of hæmoglobin, or at least a change in hæmoglobin rendering it incapable of carrying oxygen. The accompanying chart shows the average amount of reduction in oxygen-carrying power in healthy individuals subjected to one-half hour's anæsthesia under ethylene and nitrous oxide. (Fig. 1.) The entire decrease does not occur immediately, but develops between one and twenty-four hours and is from 10 per cent. to 25 per cent. of the initial figure. The return to normal requires from five to ten days. Seriously sick or anæmic patients show a proportionately greater decrease than the robust. Blood counts show some drop in red blood corpuscles, but the decrease in numbers is not enough to account for the diminished oxygen-carrying power.

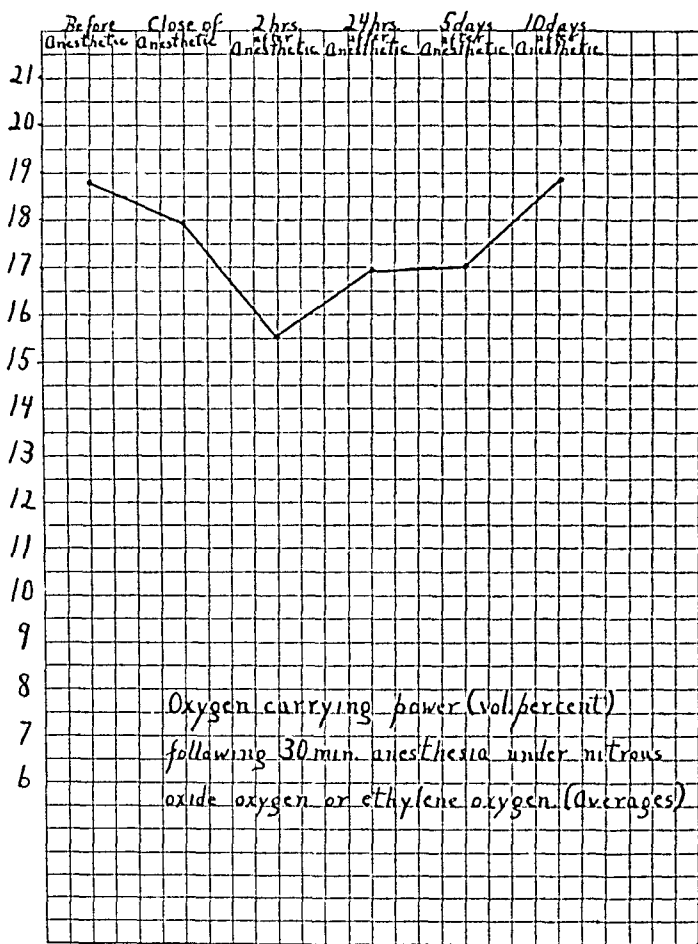


FIG. 1.

## UNTOWARD EFFECTS OF NARCOTICS AND ANÆSTHETICS

The fate of the hæmoglobin is obscure. It is not excreted in the urine in a form or quantity sufficient to be measured. The icterus index is very high a few hours after ethylene and nitrous oxide. (Ether and chloroform have not been studied.) The increase amounts to from two to three times the normal, beginning during the anæsthesia and reaching a peak from one to six hours later. A high icterus index has been found in fasting subjects only when there is increased blood destruction, as in pernicious anæmia, or in diseases of the liver or bile ducts when the bile content of the blood is augmented. Absorption of blood from wounds or from the peritoneal cavity will raise the amount of destroyed hæmoglobin in circulation. There is hardly enough liver injury following anæsthesia to account for this elevated icterus index, and, since it is elevated without operation, the increase is due to more rapid bile pigment production following hæmoglobin destruction.

Anoxæmia, produced in a dog by forcing it to breathe an atmosphere of 93 per cent. nitrogen and 7 per cent. oxygen, although causing changes in the acid-base balance similar to those following anæsthesia, does not cause a fall in oxygen-carrying power. The alteration or destruction of hæmoglobin must be the direct effect of the anæsthetic.

A patient whose oxygen-carrying power dropped 20 per cent. following the drainage of an abscess under ethylene was given a blood transfusion the next day. Five hundred cubic centimetres of whole blood brought the oxygen-carrying power back to the initial figure, thus compensating for twenty-five minutes' anæsthesia and rather insignificant operative trauma. Blood from a patient on whom an appendectomy was done under novocain infiltration showed that the operative trauma and the loss of blood do not decrease the oxygen-carrying power as much as thirty minutes' anæsthesia without an operation.

Our data on anæsthesia without operation are too limited to permit us to draw conclusions as to the comparative effects of the different anæsthetics. Apparently chloroform causes the greatest drop while the decline in oxygen-carrying power following ether, ethylene, and nitrous oxide is about the same.

The effect of this loss of intact hæmoglobin in robust patients is of only slight importance. A drop of 15 per cent. to 25 per cent. in the oxygen-carrying power of anæmic individuals or of those whose heart load is already maximal may mean a break in cardiac compensation.

The sedimentation rate of erythrocytes, with the possible exception of the total lymphocyte count, is the best single measure of the unknown quantities we term defense. The factors determining the sedimentation rate are principally in the plasma, but we know neither the mechanism nor the actual chemical and physical factors governing this rate. Conditions one would expect to retard the rate do not. Blood from severe diabetics or from those in uræmic coma, instead of sedimenting slowly, does so rapidly. A patient in severe shock when the red blood count is above five millions, so that there is considerable concentration, has a rapid rather than a slow rate. The rate

in eclampsia is much more rapid than that after ether anaesthesia, yet the known blood elements are almost identical. Although the physical reason for a slow or rapid sedimentation rate is unknown, the meaning is definite and reliable. Whether the disease be acute or chronic, bacterial or parasitic, a malignant tumor or a disturbance in a gland of internal secretion, the divergence from the normal rate is an index of resistance and defense, a measure of antibodies, hormones and chalones.

Anaesthesia increases the rate of sedimentation. The accompanying chart

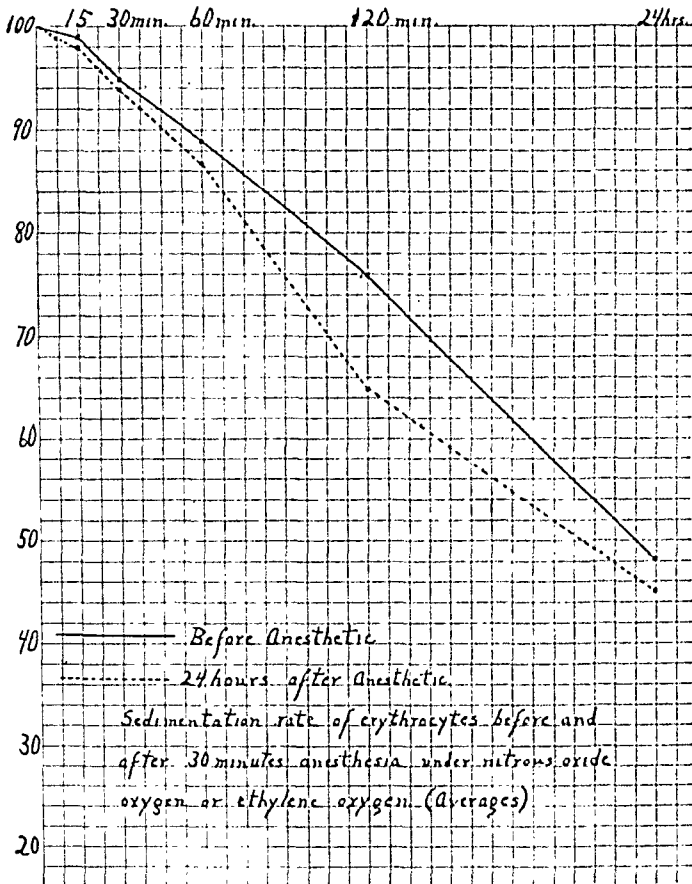


FIG. 2.

shows the variation from the normal produced in a healthy individual by a half-hour's anaesthesia. (Fig. 2.) The amount of variation is not always the same, but following ether, nitrous oxide, and ethylene (chloroform not done) there is an increase in rate. The return to normal is slower than the return of all the other blood elements altered by anaesthesia. Anoxaemia, although producing an acidosis, does not noticeably increase the rate of sedimentation.

Observations on healthy individuals under different anaesthetics are too few to warrant conclusions as to the com-

parable effects. The clinical significance of an increased sedimentation rate may not be clear, but we can be sure that following anaesthesia there is impairment of resistance, defense, and repair.

Opiates produce a slight alkalosis and so counteract in part the acidosis caused by anaesthetics.

The depth of anaesthesia afforded by nitrous oxide and ethylene is frequently insufficient for abdominal operations and attempts to produce greater relaxation by decreasing the percentage of oxygen lead to increasing anoxaemia and, therefore, increasing acidosis. Preliminary narcosis enables the anaesthetist to provide adequate relaxation for upper abdominal operations with concentrations of from 15 per cent. to 25 per cent. oxygen in ethylene. An even depth of anaesthesia is essential not only for rapid oper-

ating, but also for the welfare of the patient. Preliminary narcosis makes this possible.

The relative merits of morphin and pantopon as pre-operative drugs are no longer in doubt. There is less nausea with pantopon before the anæsthetic begins and less vomiting during the induction period. There is no appreciable difference in the post-operative period. The disagreeable sensations induced by opiates seem to be less with pantopon than with morphin.

Observations on the effects of anæsthetics with and without preliminary narcosis are too few to make definite assertions, but they seem to be less severe and the return to normal is more rapid when narcotics are used.

The untoward effects of anæsthetics are multiple and varied. The ideal anæsthetic is still in the future. Ethylene, with from one-half to two-thirds of a grain pantopon an hour and a half pre-operatively, more nearly approaches the ideal than ether, chloroform, or nitrous oxide.

# TRANSACTIONS

## OF THE

### PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held October 10, 1927*

The President, DR. CHARLES F. MITCHELL, in the Chair

#### TOTAL CARCINOMA OF RECTUM

DR. HUBLEY R. OWEN demonstrated a specimen consisting of the rectum and part of the sigmoid, which showed total carcinoma. This had been removed a few hours before by the abdomino-perineal route from a patient who had had symptoms for only a few weeks.

#### SPLENECTOMY FOR BLOOD DYSCRASIA

DR. A. P. C. ASHHURST presented a woman, a patient of Dr. Alfred C. Johnson, aged fifty-one years, whose spleen had been removed by Doctor Ashhurst at the Episcopal Hospital, June 1, 1927. The patient had entered the hospital after a few months' illness, suffering from jaundice and anæmia, the diagnosis being acquired hæmolytic icterus. Her improvement after the operation was rapid and she is now in very good health.

Also a female child, a patient of Dr. William H. Crawford, aged seven years, whose spleen had been removed by Doctor Ashhurst at the Episcopal Hospital, March 5, 1925, for chronic purpura hemorrhagica. She had had attacks of purpura for a year or more and had been in the hospital on four former occasions. Her improvement after the splenectomy was immediate. She has had no return of her bleeding and has remained in excellent health.

DR. JAMES E. COTTRELL said that the woman presented by Doctor Ashhurst was under his care in the medical ward. The salient points in the condition at that time were jaundice, anæmia of the secondary type and increased fragility of the red cells. There are two types of hæmolytic icterus, namely, the congenital and the acquired. Congenital types are by far the milder. They may persist for years and the patient suffer little from the condition, the health being interrupted at times by blood crises in which hæmolysis of the red cells with severe anæmia takes place. This is followed by return to the usual state of slight anæmia. In the acquired type, the cause of which is still unknown, a more severe condition obtains which progresses usually to a fatal termination, if not interrupted. The treatment indicated is splenectomy, which usually results in recovery. This patient had anæmia of the secondary type. No obvious source of hemorrhage could be found to account for such anæmia. In this case a most useful adjunct was the administration of a liver diet as outlined by Minot and Murphy, of Boston, which is useful not only in the treatment of pernicious anæmia—for which it was originally suggested—but for almost any severe anæmia. This case was an example of the comparative hopelessness of the condition

## RUPTURE OF BOWEL AT THE DUODENO-JEJUNAL JUNCTION

if allowed to run its usual course, and the excellent results which can be obtained by splenectomy, although the physiology of the process is shrouded in mystery as is the physiology of the spleen in general.

DR. A. P. C. ASHHURST said, in referring to the patient with purpura hemorrhagica, that he had been surprised that although the child had been in the hospital three times before no one else on the surgical staff had taken her spleen out. These patients with chronic purpura are known to be curable by splenectomy; the mortality is low and the results are admirable. In acute cases, however, the mortality is very high, and splenectomy is rarely if ever justifiable.

As to the adult woman, there is still some dispute among the pathologists and clinical men as to whether it is a case of pernicious anæmia or of hæmolytic icterus. He believes it is the latter, and the patient has certainly been vastly improved by the removal of the spleen. There is nothing mysterious or miraculous about the operation of splenectomy; if the spleen is diseased, the surgeon removes it; if the pathologist cannot determine by histological study of the spleen after it is removed the exact nature of the disease, that is the misfortune of the pathologist.

## RUPTURE OF BOWEL AT THE DUODENO-JEJUNAL JUNCTION

DR. E. L. ELIASON reported the case of a man, twenty-six years of age, who was admitted to Service C under the reporter's care at the University of Pennsylvania Hospital, at 11 P.M., May 7, 1927, complaining of abdominal pain associated with nausea and vomiting. He gave the history that while at work at a buzz saw at 8 o'clock that morning he was struck in the left upper abdomen with the end of a long plank, eight inches wide, thrown from the revolving saw. He was unconscious for a few moments. Since that time he has had severe pain in his upper abdomen with continuous nausea and vomiting. His physician gave the information that he was subject to epileptic attacks. On admission the T.P.R. was 99-84-24 with a blood-pressure of 110/70. The blood picture showed white blood-cells 20,400 and the man looked "hard hit." The abdomen presented a contused area the shape of the end of the plank over the left upper abdomen, extending from the tenth costal cartilage almost to the midline. The abdominal muscles were board-like in their rigidity and peristalsis was absent. There was generalized tenderness and pain. A tentative diagnosis of a ruptured hollow viscus (jejunum) was made. Operation was performed sixteen hours after the accident. The abdomen was opened through an upper paramedian incision. The peritoneum was markedly injected and filled with lymph and fluid. On delivering the great omentum and transverse colon, much of the patient's partially digested breakfast was found among the jejunal loops. Further examination disclosed a ragged tear about three inches long extending obliquely from in front of the first inch of the jejunum near the mesentery around the free border and across the posterior wall of the last one and one-half inches of the duodenum. In a word, the wound circumscribed the gut spirally, with the exception of a strip about three-quarters of an inch wide at the mesenteric attachment. The tear was closed by a double row of sutures and the abdomen then flushed free of food with salt solution and drained suprapubically and locally.

The patient left the operating table with a pulse of 156, but reacted

promptly and experienced a very smooth convalescence until the afternoon of the seventh day, when he had an epileptiform convulsion which lasted six hours. A few hours later, because of its being blood stained, the abdominal dressing was removed, thereby disclosing a ruptured wound with omentum and a loop of jejunum 10-12 inches long lying on the anterior abdominal wall. Under gas anesthesia these viscera were replaced and held within the abdomen by packing, no attempt being made to suture the wound. Three weeks later the granulating wound was grafted by the Reverdin method. The patient was discharged June 18, 1927, in good condition.

At the follow-up three months later he was credited with being in perfect health.

DOCTOR ELIASON remarked that this case belonged to that group termed by Sternberg, of Vienna, as "Zureckschlagen" or "kickback". L. P. Kuhn, of Chicago, in 1925 reported the following statistics to date: He quotes Sternberg as stating "that woodworkers using the revolving saw (2000 to 3000 revolutions per minute) are very prone to injuries by the wood being thrown or kicked back by the saw. In Austria of 519 accidents caused by planing machines, 221 were due to kickback. Of 135 accidents by trimming machines, 85 were due to the same, and of 514 circular saw accidents, 204 were of similar cause. Kuhn reports 55 "kickback" accidents from a rip saw or planer. Monro states that a hollow viscus filled with food is the commonest ruptured and of these the jejunum and ileum predominate. Massie reviewed 34 cases of ruptured viscus and found the greater number occurred in the jejunum and ileum. Most cases were partial ruptures rather than a complete division of the gut. J. T. Bottomley, writing on injuries of the jejunum and ileum states that unfortunately the early symptoms may not be of serious significance." In the experience of the above writers many of these patients have either continued to work or have returned to work in an hour or so, only later reporting abdominal distress. This was the case with his patient.

#### BULLET WOUNDS OF BOWEL AND OF ILIAC VEIN

DR. E. L. ELIASON presented a boy, aged thirteen years, who was admitted to Service C, under the reporter's care, at the University of Pennsylvania Hospital, January 18, 1927, giving the history that four hours previously he had been shot in the abdomen by a .22-calibre rifle bullet. On admission the T.P.R. was 98.3-100-24 and the blood-pressure 110/70. The blood count showed 12,500 white blood-cells and 60 per cent. hæmoglobin. The record of the red blood-cell count was lost.

The patient, although having considerable generalized abdominal pain, had not vomited. There was no restlessness, thirst, air hunger or apprehension. The skin was warm, but it, and also the mucous membranes, were pale. Examination of the abdomen revealed a bullet wound in the midline two inches below the umbilicus. The abdominal walls were quite rigid, peristalsis was absent and there was movable dullness in the flanks. The tentative diagnosis was that of intraperitoneal injury with hemorrhage, and operation was undertaken at once.

The abdomen was opened about the wound, which was débrided en route. When the peritoneum was opened, considerable blood was evacuated. Eight through-and-through perforations of the small gut, making sixteen wounds, were found. They were sutured with silk. One wound of the gut which



## ACUTE SUPPURATIVE PANCREATITIS

did not perforate the muscular coat was also closed. Wounds in the mesentery were sutured. Bleeding points were caught and ligated. Further investigation of the abdomen showed no further wounds in the small gut, but there was a single perforation of the sigmoid with considerable laceration of the meso of the sigmoid. These wounds were closed. Further examination revealed a wound in the posterior parietal peritoneum over the left pelvic brim where the great vessels cross it, which bled profusely. It was found to be a vein of considerable size, probably one of the iliacs at the bifurcation of the artery, but positive identification was not made. The wound was found to have practically severed the vein. Both ends were ligated. He was transfused with 250 c.c. of citrated blood after his return from the operating room. The post-operative course was uneventful. The wound remained clean and the patient was discharged on the fourteenth day after operation. Examination three months later showed the wound perfectly healed, no swelling of the limb and the patient said that he had no complaints.

## ACUTE SUPPURATIVE PANCREATITIS

DR. L. K. FERGUSON, by invitation, reported the case of a woman aged forty-five, who was admitted to the University of Pennsylvania Hospital in January, 1927, in the service of Dr. E. L. Eliason. The patient gave a history of having been in good health until 1925, when she had an attack of sudden severe epigastric pain accompanied by nausea and vomiting. A similar but somewhat less severe attack occurred four months later. Before and after these attacks the patient felt quite well, except for occasional "heartburn" which was relieved by soda. In January, 1927, a third attack occurred. There was no elevation of pulse rate or temperature and the pain was relieved by an injection of morphine. The vomiting continued and the pain became localized to the left hypochondrium with some radiation to the back. On admission her temperature was 99.4°, pulse 92, respirations 28, blood-pressure 160/70. The pain was intermittent and was confined almost entirely to the upper left abdomen. The whole abdomen was tender, especially in the left hypochondrium, and there was a slight rigidity of her left upper rectus. No masses could be palpated. Peristalsis was still present. The leucocyte count was 19,300. Because of continued pain and vomiting with increasing leucocytosis, operation was elected. As soon as the peritoneum was opened, chocolate-colored fluid escaped and several small patches of fat necrosis were seen. By elevating the colon, the posterior abdominal wall was revealed, disclosing considerable hemorrhage and retroperitoneal fat necrosis, especially on the left side. The pancreas was then exposed through an opening in the gastro-colic omentum; on opening the capsule of the gland, thin blood-tinged necrotic material escaped. The pathology seemed to be largely confined to the left side in the tail of the organ. Drainage was instituted. Her convalescence was marred somewhat by a right basal broncho-pneumonia from which she quickly recovered. She was discharged five weeks after operation, with the wound still draining slightly. She weighed 95½ pounds on the day of her discharge. During convalescence, the patient was watched for signs of diabetes. On the day after operation the blood sugar was 137 mgm. per 100 c.c., falling to 93 mgm. on the twelfth day. Sugar never appeared in the urine. Since her discharge, the patient has gained weight and is now in good health. This case presents several unusual and interesting features. (1) Three attacks of probable pancreatitis, with an interval of one and one-half years before the last attack. (2) Loss of weight, probably due to a chronic pancreatitis. (3) A final attack without the usual shock associated with an acute pancreatitis. (4) Pain and

tenderness confined almost entirely to the left upper side. (5) Pathology involving only the tail of the pancreas. (6) Recovery following drainage of the organ.

DR. A. P. C. ASHHURST asked Doctor Ferguson how soon he withdrew the drainage in his case of acute hemorrhagic pancreatitis. Doctor Ashhurst had lost his first patient with acute pancreatitis, he believes, because he withdrew the drain too soon, forgetting that in pancreatic disease there is inhibition of adhesion formation; the pancreatic ferments prevent adhesions. The afternoon on which this patient had the drain removed, about the fourth day after operation, she developed general peritonitis and died a day or so later.

DR. L. K. FERGUSON said in reply that his patient had the pathology located almost entirely in the left side; as soon as the gastro-colic omentum was opened the lesion was apparent. Two kinds of drains were used: a split rubber tube, containing a wick, and a tube of soft rubber. One split rubber tube extended to the tail of the pancreas and the other was placed into the opening in the gastro-colic omentum. These were both coffer dammed with the soft tubes; four of the latter being used. The soft tubes were taken out gradually and removal completed in one week. The other tubes were allowed to remain for fifteen days.

#### UNILATERAL BRONCHIECTASIS—EXTRAPLEURAL THORACOPLASTY

DR. JOHN B. FLICK reported the case of a woman aged thirty-seven, who was referred by the Jackson Clinic to the Surgical Service of Dr. John H. Gibbon at the Jefferson Hospital in November, 1926, with the history that when five years of age she sucked into her lungs a coffee bean with the result that she became quite ill with an attack simulating pneumonia. One month after the onset, she coughed up the bean and her condition improved materially, but she never got rid of the cough. When eighteen years of age she was told she had bronchiectasis. For the past eighteen or nineteen years, she has had almost yearly attacks of severe acute infection of the respiratory tract. From March, 1925, until she was operated upon, she was confined to her bed almost continuously, had a fetid expectoration and brought up small amounts of dark blood on the slightest exertion. Prior to her admission to the surgical wards, she was studied by Dr. Louis H. Clerf of the Jackson Clinic and bronchoscopic treatment undertaken. Under bronchoscopic drainage her general condition improved. She gained in weight, brought up less sputum, and the fetid odor was definitely lessened. Bronchoscopic examination showed quantities of pus coming from the left bronchus. Iodized oil was introduced through the bronchoscope and Röntgen-ray studies made which showed extensive bronchiectasis and pulmonary fibrosis, involving the lower lobe of the left lung and a portion of the upper lobe. (Fig. 1.) Repeated sputum examinations failed to show tubercle bacilli. The amount of sputum at the time of the first operation varied from seventy-five to one hundred and twenty-five cubic centimetres in twenty-four hours. The temperature was normal, with occasional periods of low-grade fever.

November 19, 1926, under local infiltration (one-half of one per cent. novocain) anæsthesia and nitrous-oxide oxygen analgesia, through a posterior incision, sections of the eleventh, tenth, ninth and eighth ribs were

## UNILATERAL BRONCHIECTASIS

removed. Following this operation the sputum diminished about a third in amount. December 3, sections of the seventh, sixth, fifth and fourth ribs were removed. December 13, sections of the third, second and first ribs were removed. Following this she was sent to a Convalescent Home for two weeks.

January 31, 1927, she was readmitted to the Jefferson Hospital for further study. She had gained eight pounds in weight and was up and about for the first time in two years. Doctor Clerf again introduced iodized oil through a bronchoscope, and Röntgen-ray studies were made to determine if possible to what extent the bronchiectatic cavities had been collapsed. It was decided that further resection of ribs would be necessary. This was done in two stages. February 21, sections of the eleventh, sixth, fifth and fourth ribs, from the point of costochondral junction, were removed through an axillary incision. March 4, an additional seven centimetres of the third and four centimetres of the second ribs were removed. The total amount of rib resected was one hundred and sixty centimetres. The patient made a good recovery and April 13 was permitted to leave the hospital. The sputum no longer had a fetid odor, had diminished in amount to ten or fifteen cubic centimetres in twenty-four hours and only occasionally contained blood streaks. October 6, the patient returned for observation. Her improvement in general appearance was most striking. She had gained ten pounds in weight, was able to be about and do part of her housework, which she had not been able to do for three years, and stated that she expectorated only in the mornings except when she had an acute cold. Her sputum had contained blood on three occasions only since her discharge from the hospital. Pneumonographic studies made at this time showed marked diminution in the size of the cavities. (Fig. 2.) The speaker said that surgery in the treatment of bronchiectasis, which involves more than one lobe, even if it be limited to one side, can at most be only palliative. Yet the amelioration of symptoms following surgical collapse of the affected side, as reported by Hedblom and others, would seem to justify its employment.



FIG. 1.—Röntgenogram made after bronchoscopic instillation of iodized oil, showing extensive bronchiectasis and pulmonary fibrosis involving the left lower lobe and a portion of the upper lobe. (Report on Röntgen-ray by Dr. W. F. Manges.)

DR. LOUIS H. CLERF said this patient had been an invalid for a number of years, and was constantly in dread of pulmonary hemorrhage. Bronchoscopic treatment was instituted and was followed by definite improvement. Realizing that bronchoscopy has definite limitations in these cases in so far that pus will reaccumulate following aspiration, if nothing is done to remove the diseased area, the speaker believed that the surgeon should be given an opportunity to consider the advisability of surgical interference. Doctor



FIG. 2.—Röntgenogram made after bronchoscopic instillation of iodized oil, shows diminution in size of bronchiectatic cavities, following extrapleural thoracoplasty. (Report on Röntgen-ray by Dr. W. F. Manges.)

Flick saw the patient and thought that much could be gained by operation. The improvement which resulted was remarkable. From the standpoint of the bronchoscopist, one outstanding feature is the aid which can be given to the surgeon; often after a course of bronchoscopic treatments the patient improves to such an extent that he is in better physical condition to be operated upon. The bronchoscopist can also be of great assistance in locating bronchiectatic cavities; no one, not excepting the röntgenologist, had an idea the cavity in the left chest was as large as the pneumonograms showed.

By the bronchoscopic instillation of iodized oil it was possible to give the surgeon information as to what had been accomplished and the last pneumonographic studies made October 8, showed a marked contrast when compared with the original studies.

#### ABDOMINAL INCISIONS, THEIR MAKING AND CLOSURE

DR. IRVINE M. BOYKIN read a paper with the above title, for which see page 74.

DR. A. P. C. ASHHURST said, that he wished to discuss especially two points in Doctor Boykin's paper: first, the exposure which one can secure by the incisions described; and second, the complication of the wound breaking open.

## ABDOMINAL INCISIONS, THEIR MAKING AND CLOSURE

As all know, the linea alba and the linea semilunaris are the two resistant structures in the abdominal wall: if one cuts across one or both of them, one can get a great deal more exposure through a small incision than if one cuts between them. The gall-bladder incision Doctor Boykin describes is better than a transverse incision, because it affords an exposure high up in the midline, as well as sufficient exposure of the fundus of the gall-bladder. Professor Terrier long ago pointed out that biliary surgery tended to become more and more *canaliculaire*; and it is because one cannot get sufficient exposure of the ducts through the longitudinal portion of an upper rectus incision, that Mayo-Robson added the extension of such an incision upward to the ensiform below the costal border. For a time Doctor Ashhurst had used Mayo-Robson's incision; but very soon a patient returned complaining of a large bulge caused by paralysis of the rectus muscle between the incision and the midline. The patient wanted to know what had been cut. About that time an article on abdominal incisions, written in 1908 by a Doctor Collins, a gynecologist, of Peoria, Ill., had come to Doctor Ashhurst's attention; and this incision for gall-bladder operations which Doctor Ashhurst has used for many years is the same as that described by Collins, only longer. By cutting the linea alba at the upper end, and (when necessary, also) the linea semilunaris at the lower end, the two most resistant structures in the abdominal wall are cut, giving admirable exposure of the bile-ducts.

Concerning Doctor Boykin's remarks about the draining of appendix incisions, Doctor Ashhurst was not convinced that one gets fewer hernias if the drain is placed at the linea semilunaris rather than at the outer end of the incision, where one has the entire thickness of the transversalis and internal oblique muscles, as well as the muscular fibres of the external oblique; because a drained incision is often long enough to involve some of the muscle fibres of the external oblique. The speaker makes a practice of placing the drain at the outer end of the incision. Doctor Crossan had called Doctor Ashhurst's attention to an observation by the late Dr. James E. Thompson, of Galveston, to the effect that while many of the transverse incisions seem to have hernias at the end of six months or a year, in one or two years more the hernia has disappeared and the wound is firm.

As to the question of wounds breaking open again, Doctor Ashhurst said that a few years ago he had been asked by a surgeon from another city how many abdominal wounds he had had that broke open after operation. Doctor Ashhurst had replied *one*. "Do you mean to say," replied Doctor X, "that in your *entire* experience you have had only one wound break open?" To which Doctor Ashhurst had replied he thought one was enough. Doctor Ashhurst had then inquired from his friend, who seemed to be troubled so often by his incisions breaking open, what was the method he used in closing his abdominal incisions. "In layers, and with mass sutures of non-absorbable material, such as silkworm gut," was the reply. To Doctor

Ashhurst's query whether Doctor X ever closed his wounds with nothing but through-and-through sutures of silkworm gut, the reply was a hesitating "yes", with the explanation that this method was not popular with Doctor X because he had several times had loops of bowel prolapse and become strangulated between these sutures, not so far out as to reach the skin, but at least through the peritoneal surface of the wound. Then Doctor Ashhurst had suggested that perhaps the through-and-through sutures had not been placed closely enough, since in his own experience such an accident had never occurred. Doctor X replied that in an incision about 15 cm. long, he was in the habit of inserting two or three such through-and-through sutures. Now this, Doctor Ashhurst believed, was the explanation of the apparent frequency with which Doctor X's wounds, even when closed in layers, had broken open. Doctor Ashhurst was convinced that if only through-and-through sutures were used, they should be placed not more than 1 cm. apart; and when the wound was closed in layers, the splint sutures should be not more than 2 cm. apart. Moreover, it was very important not to remove either the splint sutures or the through-and-through sutures too early: the former seldom in less than ten days, and the latter scarcely ever in less than two weeks after operation.

On carefully searching his records, Doctor Ashhurst had found a second patient in whom this accident occurred, but it was not an incision in the epigastrium, where most of such disasters have occurred in the experience of others, but a long left paramedian incision, made for purposes of complete exploration and which had been closed in layers and with six splint sutures; moreover, in this case the interne by inadvertence had removed the splint sutures on the eighth day after operation. In the other case, where an incision 15 cm. long (for gastrojejunostomy) had been closed in layers and with five splint sutures of silkworm gut, the wound broke open on the fourth day after operation, and the transverse colon protruded: the two silkworm gut splint sutures at the middle of the wound had broken, but the lowermost and the two upper splint sutures had held. The wounds of both these patients were re-sutured under gas anæsthesia, with nothing but through-and-through sutures of silkworm gut placed 1 cm. apart. Both patients made an uneventful recovery: the first patient, a man sixty-one years of age, developed an incisional hernia, partly because he rapidly gained 40 pounds in weight after operation; the second has a firm incision without any tendency to hernia. Both patients have been followed for six years after operation.

DR. GEORGE P. MULLER said that for many years he used the right rectus incision in the lower abdomen and believed this to be the usual practice among Philadelphia surgeons. Of late years the speaker has used the paramedial incision. His reason for preferring this to the right rectus incision being that in the former, one did not encounter the deep epigastric vessels. The speaker still uses the right rectus incision in the upper abdomen, particularly in gastric work, and finds that if the wound is carefully closed and

## ABDOMINAL INCISIONS, THEIR MAKING AND CLOSURE

rigid asepsis is maintained, hernia does not often occur. In gall-bladder work Doctor Muller uses the incision described by Doctor Boykin and has found it satisfactory. In all acute cases of appendicitis the speaker uses the McBurney incision; this differs very little from the Davis incision except as regards the direction of the skin incision. The successful healing of wounds depends on the prevention of infection, the elimination of rough handling and a neat, accurate approximation of tissues without tension. The only cases in which the speaker has had wounds break open are in extensive exploratory operations, for cancer of the stomach where closure has been difficult, due to strain. Surgeons are apt to concentrate their interest in the main features of an operation and have the work undone by the condition of the wound.

Dr. I. M. BOYKIN said that his sutures embrace all structures down to the posterior sheath of the rectus and are placed two and one-half cm. apart. He thought that Doctor Muller was mistaken in saying that the McBurney and Davis incisions are the same except for the skin incision. He will find in the follow-up clinic that in the McBurney incisions, that had to be extended, there is permanent damage done to the abdominal wall. This is not true of the transverse incision.

both upon physical examination and from röntgenograms. Blood count normal. Patient sent to a convalescent home in the country, where she continued to gain slightly, but on October 3, 1924, she was re-admitted to the hospital with cough, fever, anorexia, and languor. At this time she presented the same physical findings as at the time of discharge. These were a small area of dulness in the left inter-scapular area near the angle of the scapula where there was diminished voice and breath transmission, slight bronchial difficulty, and a few clicking râles extending upward to the spine of the scapula and anteriorly blending into the area of the pericardium. Slight irregular pyrexia, considerable non-productive coughing and no fetid breath. She had remained well nourished and was not acutely ill. The most outstanding development was a rapid extreme clubbing of all fingers and toes and suggested chronic pulmonary osteo-arthritis. Bronchoscopy by Doctor Kernan showed no pathology of the bronchi and no evidence of bronchiectasis. Repeated exploratory thoracentesis over the pathological area in the left lung was also negative until November 12, 1924, a needle introduced into the fifth interspace in the anterior axillary line corresponding to a point with left arm on top of head one inch anteriorly and on a level with lower angle of scapula needle inserted slightly upward and inward and backward for a distance of 5 cm., a few c.c.'s of thick gelatinous greenish-yellow pus, odorless, was obtained. It could be plainly seen that the needle moved not only with respiration but also with pulsation of the heart. Fluoroscopy with needle in place showed abscess to have been entered at lower level. Stereo-röntgenograms taken with needle *in situ*. Bacteriologic examination showed again pneumococci. November 19, 1924. Thoracotomy with rib resection and lung exploration under  $\frac{1}{2}$  per cent. novocaine. Three inches of sixth and seventh ribs resected in axillary line. Pleura appeared thick and no moving lung could be noted beneath it. Needle encountered thick, heavy tissue but no actual pus was obtained. Three inches of the fifth rib then resected and the lung entered with the actual cautery. The lung tissue was hard, not actually fibrous, but consolidated and atelectatic. During this whole procedure the patient did not cough or expectorate any bloody fluid, showing conclusively that the pathology was in the lung and not in the bronchi. Further explorations continued until the pericardium was encountered, but no pus found; the wound packed with iodoform gauze. Röntgenograms showed that the actual abscess itself was lower than where the exploration had been done. Second operation November 26, 1924, incision and drainage of lung abscess. No anæsthesia. On removal of tampons inserted at first operation the lung cavity made at time of first operation had retracted and enlarged. There were several easily visible bronchial openings through which air passed freely, showing that this portion of the lung which had been consolidated from compression and in which there had been no evidence of bronchial fistula had now become relieved of pressure and was allowing air to circulate through it. With the actual cautery a cavity  $5 \times 3 \times 3$  cm. was entered under the seventh rib in the axillary space. This contained thick, gelatinous pus with fibrin. The cavity was found to be divided into two halves by a shelf of lung tissue. In order to obtain better drainage, this shelf was removed and iodoform tampons introduced. Again the pus was found to be of pneumococcus origin and peculiarly enough the shelf of lung tissue removed was found to be tuberculous. The post-operative course was uneventful and three months later, February 17, 1925, the wound with the bronchial fistula had closed. Röntgenograms at that time and later showed no further pathology in the lung tissue and no evidence of consolidation from tuberculosis or abscess. The child was



## CONCOMITANT GASTRIC AND DUODENAL ULCERS

referred to a convalescent home and immediately gained weight and became perfectly normal. She is now still perfectly well. The points of interest are the ubiquity of the pneumococci and the fact that a true pneumococcus pus in the lung itself if not secondly contaminated did not cause acute symptoms, and thirdly, that a localized lung pathology frequently means abscess and demands surgical intervention.

### CONCOMITANT GASTRIC AND DUODENAL ULCERS TWO AND ONE-HALF YEARS POST-OPERATIVE

DR. OTTO C. PICKHARDT presented a woman, age fifty-eight years; single. Admitted to the Lenox Hill Hospital, January 31, 1925. *History*.—Sailed from Germany December 31, 1924, feeling well. Had usual seasickness with loss of appetite and vomiting. Seven days before admission sudden sharp cramp-like pains in right upper quadrant. No radiation. Anorexia. No vomiting. *Past History*.—Thirty years ago in bed two days with abdominal cramps. Two years ago sharp pains in right upper quadrant. Loss of weight; ten pounds in two months. Has always taken care of her diet because sour foods caused vomiting. *Physical examination*.—In right upper quadrant distinct tender mass two inches below costal margin and one inch to the right of umbilicus, smooth, firm, and fixed. Temperature 100 to 101, pulse 80. Test-meal showed slight increase of acid. Blood count normal. Wassermann negative. Blood chemistry normal. Feces—trace of blood. Röntgenograms showed (1) penetrating ulcer of lesser curvature in middle third; (2) annular growth of pylorus and obstruction; (3) deformity to pylorus suggesting scarring and ulceration. No evidence of vigorous peristalsis. Marked six-hour retention to twenty-four hours. *Diagnosis*.—Lay between multiple ulcers and malignancy.

At operation, February 19, 1924, there were found four ulcers—two in the stomach and two in the duodenum, as follows: (1) On the anterior surface of the duodenum just distal to the pyloric vein, was a freshly perforated ulcer which had attached itself to the peritoneum opposite and to the right of the umbilicus, causing the stomach to be twisted upon itself. There was very little induration around the ulcer but a great deal of redness and inflammation and fresh new adhesions. (2) On the posterior aspect of the duodenum at the junction of the first and second parts and comprising almost the whole of the portion posteriorly, there was a large, soft, and lightly indurated mass which showed through an area of redness and scarring when the duodenum was turned. The duodenum was greatly increased in diameter, being about two and one-half times its normal size. (3) At the lesser curvature, about midway between the pylorus and the cardia, was a large soft mass also situated at the posterior aspect of the stomach about one by two inches in diameter. No crater could be felt, but there was visible some puckering of the gastro-serosa posteriorly; it was not attached to the pancreas. (4) On the anterior surface of the stomach midway between the lesser and greater curvatures, there was a small healed area with very little induration, and it was attached by long, old adhesions to the gastro-splenic ligaments. The cardiac portion of the stomach was normal. In view of the extensive findings of the evident pyloric obstruction and of the extent of the ulcer on the lesser curvature, it was decided that resection of the stomach was neither indicated nor feasible, but that a posterior gastro-enterostomy was for the best interests of the patient. This was done in the usual manner, using Roosevelt clamps, silk for the sero-serous suture, and fine chromic for the internal sutures. The gall-bladder appeared normal and the foramen of Winslow was patent. At the close of the operation the omentum was

distributed partially over the buried ulcers. Post-operative course normal until the eighth day. At that time patient began to vomit dark foul material, in which was found a large *Ascaris lumbricoides* worm. This continued for three days, the vomitus becoming more bile filled. Apparently a middle vicious circle was present, but this cleared up under lavage. Patient left the hospital, April 20, 1925, feeling perfectly well and having gained twelve pounds in weight. A roentgenogram taken just before discharge showed the barium meal passing out through both the pylorus and the stoma. There is seen a pouching on the greater curvature producing a sacculation, and there is still considerable dilatation in the third portion of the duodenum. The stomach completely emptied in six hours. A follow-up roentgenogram, February 18, 1926, showed the gastro-enterological stoma to be working in a normal manner. The stomach empties completely within four hours. There is evidence of retention of the barium in what apparently is the ampulla of Vater. This disappeared completely in six hours. The patient is now still perfectly well and is doing regular housework. She is only moderately careful of her diet and weighs 133 pounds. She has a good appetite, no heartburn or nausea, and has taken no medicine of any kind since then. She states that she does not know she has a stomach.

#### STRANGULATED UMBILICAL HERNIA WITH GANGRENE OF TRANSVERSE COLON

DR. MORRIS K. SMITH presented an elderly woman who was admitted to St. Luke's Hospital, May 31, 1927, with the diagnosis of strangulated umbilical hernia. For twelve years she had had a large hernia. It had always been reducible until 1 P.M. of the day of admission, at which time it came down and could not be replaced. She had vomited once and been in pain. Examination revealed a woman of seventy-two, acutely ill, although not prostrated. Just above the umbilicus the hernia presented as an irreducible rounded hard mass the size of a large fist. The skin over it was reddened. Operation was done under local anæsthesia seven hours after onset of strangulation. On opening the sac there came into view eight inches of gangrenous transverse colon. On account of the patient's age and condition it seemed as if primary resection would be quite hazardous, so a first-stage Mikulicz was done. The spur was opened the next day and three days later cut away. The clamp had to be applied twice before the loops were cut through sufficiently deeply. Two months after the first operation the fistula was closed operatively. There was almost no fecal drainage after this and the wound healed satisfactorily.

At no time did the patient seem critically ill. For the first two to three weeks she had a moderate amount of fever due to suppuration in the wound. After this the general condition improved steadily.

This case is presented not as showing anything new, but as illustrating the application of this relatively safe method of resection of the colon in strangulated hernia in an elderly patient. It is not the method of choice either from the standpoint of cure of the hernia or rapidity of recovery. From the standpoint of saving life it seems a desirable method in similar cases.

DOCTOR SMITH said he had been very much surprised to find the gangrenous loop, considering the short history, and believed it possible the strangulation had begun earlier than reported. The woman's son had always previously been able to reduce it and he had made a thorough trial to again

## RECURRENT DISLOCATION OF THE SHOULDER

accomplish this before the mother was taken to the hospital. The ring was very tight and the gut so black that there was no question of the non-viability.

## RECURRENT DISLOCATION OF THE SHOULDER

DR. MORRIS K. SMITH, referring to an article by Dr. Melvin S. Henderson, entitled "Tenosuspension for Habitual Dislocation of the Shoulder," which appeared in *Surgery, Gynecology and Obstetrics* for July, 1926, presented two cases of recurrent dislocation of the shoulder.

CASE I.—A man, age twenty-three, was admitted to St. Luke's Hospital, August 6, 1926. Two years previously he dove into shallow water with arms outstretched and dislocated the left shoulder. Since then it has dislocated five more times, the last two weeks before admission.

*Operation.*—Curved incision with convexity downward over upper end of humerus and acromion process. Horizontal drill holes were made through the end of the acromion and the greater tuberosity of the humerus, the latter being approached through vertical incisions in the deltoid. A strip of fascia lata was next removed from the thigh, brought through the drill holes, and the ends sutured together with silk, thus providing a check ligament to dislocation of the humeral head. The fascial strip was reinforced by a loop of braided silk and the wound closed.

The arm was at first bandaged to the side. The patient was discharged on the tenth day and instructed not to abduct to a right angle inside of three months. Thirteen months later he reported that he had had no more dislocations and has good use of the arm. He has played baseball. Examination shows slight limitation of abduction, otherwise motion free.

CASE II.—A man, aged twenty-three, was admitted to St. Luke's Hospital, August 21, 1926. Three years before he dislocated the right shoulder in a fall from a horse. Since then the dislocation has recurred five times from minor injuries, the last time six weeks previous to admission.

Operative procedure the same as in Case I except that the reinforcement of braided silk was not used. This patient was also discharged on the tenth day with instruction not to abduct arm for three months. He was if anything overcautious in resuming movements. He has had no further dislocations and is now doing manual work on a railroad. Motion is excellent.

DOCTOR SMITH said that in the operative procedure he attempted to follow Henderson's technic except that he used fascia lata instead of the tendon of the peroneus longus. In his article he reported three cures by tenosuspension, the longest follow-up being 22 months, with no recurrences. As contrasted with this there were at the Mayo Clinic 19 follow-ups (over a longer time it is true) on capsulorrhaphies with 42 per cent. cured and 32 per cent. decidedly improved and 8 Clairmonts (muscle sling plastic) with 63 per cent. cures.

Dr. Carl Beck, of New York, presented a case of recurrent dislocation before the Surgical Section of the Academy of Medicine in December, 1902, and reported it in the *New York Medical Journal* for July 11, 1903 (referred to by Henderson) in which he had done at the same time a capsulorrhaphy and passed a silver wire through drill holes in the head of the humerus and acromion. He removed the wire in six weeks. The result at the end of six months he described as perfect.

DR. ALBERT E. SELLENINGS referred to a case in which the patient had received injury to his shoulder by a fall from a ladder and after that he dislocated it repeatedly, as many as fourteen times. A modified Thomas capsulorrhaphy with crucial suture was done. After four months the man was able to engage in all sorts of activities, including swimming, and has since remained well. The operation was performed two years ago.

DR. CONSTANTINE J. MACGUIRE, JR., referred to a case in which he had used braided silk for suturing the acromial end of the clavicle to the coracoid process in dislocation of the outer end of the clavicle, in which case a fistula formed six months later, requiring removal of the braided silk, which had worked completely through the clavicle. He felt that it was possible that the same situation might result in the use of braided silk in Doctor Smith's case.

DR. JOHN M. HANFORD said that he had done the Kellar operation in one patient with recurrent dislocation and the technic had been apparently satisfactorily accomplished. The patient was seen about two months ago and stated that a recurrence had occurred while swimming about a year after the operation.

DOCTOR SMITH, in closing the discussion, said that he had recently read an article by Carrel who described a recurrence after the teno-suspension operation. The speaker did not believe that any method whatever would give 100 per cent. cures. He believed the prolonged immobilization of the arm to be an important part of the treatment. The teno-suspension method appealed to him because of its simplicity and the avoidance of risk of traumatism to important structures. As to Doctor MacGuire's prophesy, it did not seem likely that the braided silk would cut through the acromion in this case as there was no tension on it such as was necessary in Doctor MacGuire's case.

#### ACUTE HEPATIC DEGENERATION—CHOLECYSTOGASTROSTOMY

DR. CHARLES GORDON HEYD presented a young man, twenty years of age, who entered the New York Post-Graduate Hospital, October 6, 1926, complaining of jaundice, nausea and vomiting; weakness; mental depression and with a loss of twenty pounds in weight during the preceding six weeks. The patient's present illness began about two months ago with fever and weakness. Patient states that he ran fever for three days and at about the same time began to lose strength and weight and was frequently nauseated at this time. About two weeks after the onset of fever the patient became jaundiced which increased in intensity for three weeks and then faded away. After an interval of a few days in which the jaundice was distinctly diminished, there was an increase in the intensity of the jaundice, with fever and vomiting becoming more frequent. There was no pain, although there was considerable belching and eructation of gas. Patient states that his stools were gray in color but otherwise not noteworthy. Patient had a mastoid operation, a septum operation, and adenoids and tonsils removed some eleven years ago. When he was admitted to the hospital he was intensely jaundiced with marked itching and no petechiæ. Physical examination was negative except for tenderness in the right upper quadrant, a palpable liver and pal-

pable spleen. The tentative diagnosis was obstructive jaundice—possibly of toxic origin. The leucocyte count was 11,800; 74 per cent. polynuclearphils; red cells 4,952,000 per cubic mm.; hæmoglobin 96 per cent.; platelets 224,600 per cubic mm.; Wassermann was negative; the icteric index was 100, Van den Bergh direct +, Van den Bergh indirect +++: Fouchet +++. October 17, the icteric index was 166.6, Van den Bergh, direct +++++, Van den Bergh, indirect +++++, Fouchet +++++.

X-ray examination of the gall-bladder region revealed no evidence of calculi. The right lobe of the liver was markedly enlarged but its free border quite smooth. X-ray examination of the kidneys was negative. X-ray examination of the gastro-intestinal tract was negative except at the end of twenty-four hours there was considerable irregular distribution of the barium meal suggesting irregularities of colonic spasm with a stasis of material in an irregularly filled segmented appendix. The stools were uniformly clay colored but did give a trace of bile.

The patient's progress was continuously worse, jaundice increased in intensity, mental depression and pruritis were exaggerated. Vomiting became a prominent feature for ten days previous to operation. At operation, October 20, 1926, the liver was found to be about twice the size for the patient's age, weight and stature. There was no evidence of fibrosis of the capsule of Glisson. There was about 300 c.c. of pale ambre ascitic fluid in the abdomen. The gall-bladder was thickened, without stones; increased thickness of the gall-bladder wall was apparently due to cedema. The common duct was narrow, not thickened nor dilated. The lymph-glands at the junction of the cystic and common duct were enlarged. The pancreas, if anything, was softer than usual. The gastro-duodenal segment was negative. The lower abdomen was not explored: the appendix was left *in situ*. Operation consisted of a cholecystogastrostomy with the application of the gall-bladder to the lesser curvature of the stomach about three cm. from pyloric ring. Suture line was reinforced by wrapping a portion of the greater omentum about it and a small cigarette drain was inserted into Morrison's space. Aside from nausea which lasted for six days the post-operative convalescence was uneventful. Seven days after operation the icteric index dropped to 101, while the Van den Bergh direct and indirect were still +++++ and Fouchet +++++. Two weeks after operation the icteric index was 65, Van den Bergh direct and indirect +++, Fouchet +++. From this time on the patient had a constantly diminishing jaundice and was discharged on the twenty-sixth day after operation with normal colored stools and practically free from jaundice, although the sclera were suggestively yellow.

This patient presented a condition characterized by an intense progressive jaundice that was sequential or associated with a febrile attack. The clinical and chemical evidence was such as to suggest complete biliary obstruction. The feeling of his attending physician was that this patient had had an initial attack of influenza. The stools in the beginning were bile colored but later became clay colored with practically an entire absence of bile. This is the third case of this type that we have had in the last three years and in none of them has the gall-bladder been palpable nor has there been any suggestion as to the applicability of Courvoisier's law. X-ray studies did not reveal any gall-bladder disease. The liver on laparotomy has been smooth and glistening and nearly of normal color, but of about twice the normal size. There was no evidence of interstitial fibrosis such as is observed in long-continued abdominal affections and gall-bladder disease. The gall-bladder itself was cedematous and hypervascularized but did not contain bile but colorless mucoid material. Cystic and common ducts were not obstructed

although œdematous. It would seem that the underlying pathology in this patient was that of an infectious or toxic condition with degeneration of the hepatic parenchyma. As a result of the destruction of the liver cells the bile canaliculi become blocked with broken-down cellular detritus and bile thrombi. The cytolysis of liver cells continues with a collection of bile into so-called "lakes", thus there are two pathological factors at play, (1) the primary destructive action as the result of a hæmatogenous process and (2) the mechanical feature with obstruction of the small bile canaliculi. The final result so far as the liver is concerned is the development of a marked and gross œdema of the entire liver. A condition well described as a hydro-hepatosis. These changes may be followed in the histological examination of specimens of liver removed at the time of operation.

The question arises of what benefit was a cholecystogastrostomy. It would appear that the surgical indication in this case was to deplete the liver tissue of its fluid, in other words, to relieve the passive congestion and œdema. This could be accomplished by multiple incisions in the liver, but the effect of hemorrhage would prohibit this procedure. The only other way of producing a loss of fluids and relieving the œdema factor was to devise an adventitious means of lymphatic drainage. This could either be accomplished by a cholecystostomy or a cholecystogastrostomy. In the former there would be the loss of bile, not to be lightly considered, and in the latter there would be established a lymphatic depletion of the liver with delivery of bile into the gastro-intestinal tract. This was the reasoning that prompted us to do a cholecystogastrostomy in the presence of an obstructive jaundice that was apparently within the liver and in the presence of normal gall-bladder and biliary passages.

CASE II.—DOCTOR HEYD also presented a woman who had appeared before the New York Surgical Society in April, 1926, and was reported in the *ANNALS OF SURGERY* for November, 1926. This patient had had a cholecystogastrostomy performed for what was tentatively assumed to be an acute catarrhal jaundice. The small portion of the gall-bladder removed in making the cholecystogastrostomy ostium on histological examination showed no evidence of any pathological change. The pathological report on the liver tissue showed the lobular structure was easily recognizable. The Glisson's capsule was thin and several lobules near this surface as well as in the deeper areas showed changes within the centre of the lobules. The changes were characterized by the disappearance of liver cells to such an extent that the centre of the lobules showed only the framework without liver cells. In these areas of the liver lobules there was a proliferation of the endothelial cells and numerous lymphocytes and occasional polymorphonuclear leucocytes were to be seen. The liver cells, particularly near the centres, which were preserved, showed parenchymatous degeneration occasionally with karyolysis. There was only a small amount of bile pigment recognizable in the cells. The picture was that of a central necrosis of the liver lobules. It could be compared to the changes of acute yellow atrophy, only it was of a much milder degree. Doctor Heyd presented this patient as evidencing a remarkable recovery from a grave liver injury and as indicating the marked degree of regenerative power possessed by the liver as the patient had given birth to a normal baby on July 30, 1926. She had an uneventful pregnancy and puerperium and had enjoyed good health since the time of her operation.

DR. EDWIN BEER remarked that Doctor Heyd had not mentioned in presenting his cases whether there had been any temperature, or whether

any Lyon's test had been made. He personally has seen a number of these cases which looked like serious cases of catarrhal jaundice clear up when magnesium sulphate was fed through a duodenal tube into the duodenum, no surgical interference being necessary.

It would seem, in view of the fact that, as Doctor Heyd has subsequently stated, no bile was found in the intestines when a Lyon's test was made, and in view of the fact that the patient vomited bile after the gastric anastomosis with the gall-bladder, there had been an obstruction in the peripheral part of the common duct, the exact nature of this obstruction being undecided. A better proof that Doctor Heyd was dealing with such an obstruction would be difficult to find.

DR. JOHN DOUGLAS referred to Doctor Heyd's apparent contention that so-called catarrhal jaundice is really hepatic degeneration. Most of the cases of catarrhal jaundice get well without operation, but the speaker had seen two patients die within the last year, and it appeared impossible to do anything for them. Therefore, if Doctor Heyd has found a method of curing such cases he has made a valuable contribution to surgery, but Doctor Douglas failed to see the connection between the operation and the cure of the patient, except in point of time. If they have degeneration of the liver cells it is presumably due to some toxin. There is no obstruction to drainage of the big ducts and the obstruction is apparently in the small radicals. As to Doctor Heyd's explanation that there is lymphatic drainage sufficient to relieve the pressure on these small radicles; while it is true that the lymphatics of the liver and gall-bladder communicate, the gall-bladder has few lymphatics and it is difficult to understand how by this anastomosis between the gall-bladder and the stomach sufficient lymphatic drainage can be established in such a short period of time that the patient will drain sufficient bile into the stomach to vomit bile in 24 to 48 hours. Doctor Douglas thought it would be worth while for Doctor Heyd to report more of these cases with results, but the theory of lymphatic drainage to cure a degenerative condition due to toxins did not appeal to the speaker sufficiently for him to attempt to operate for this purpose.

DR. ALLEN O. WHIPPLE reported a case which was very similar to the two of Doctor Heyd, the only difference being that nothing but an exploratory operation was done. The patient nevertheless got entirely well. He had no explanation for that. This patient, a woman, had had pernicious anæmia for five to six years and had improved remarkably on a liver diet. She later had been under observation for two months, during which there was deep jaundice elevation of temperature and some tenderness over the liver area. After failure to get bile through with the Lyons test an exploratory was advised and the liver was found to be enlarged. The astonishing part was that the common duct was not distended. The impression was received, through the collapsed appearance of the gall-bladder, that the liver had stopped passing bile into the duct system. Because of lack of evidence of obstruction in the common duct, the wound was closed and nothing

further was done. On the third or fourth day the patient was given glycerin and Vichy and promptly began passing bile, the symptoms cleared up and she has now remained well for a period of eight months.

DOCTOR HEYD, in closing, stated that the patient presented was admitted to the Post-Graduate Hospital, under the care of Doctor Mosenthal. The preliminary diagnosis was that of chronic jaundice secondary to acute influenza. In spite of the most approved medical therapy, including the Lyons' method, the patient progressively became worse and in the opinion of three consultants was considered hopeless. From their previous experience it was suggested that a cholecystogastrostomy be done irrespective as to the pathological condition that was causing the obstruction. This was carried out and the patient progressed to complete recovery. Doctor Douglas' objection is perfectly valid and in searching for the reason for the cure of this patient they could only assume that the cholecystogastrostomy provided a means for relieving the œdema and congestion of the liver. Previous histological studies of the liver showed the remarkable destruction of liver tissue, with œdema. Surgically, the operator could have relieved the œdema of the liver by making multiple incisions but this would have been absolutely impossible on account of hemorrhage. It is well to recall that the greatest degree of liver enlargement in acute hepatic necrosis is due to the serum that is present in the liver. Experimentally, it has been demonstrated that the removal of an acutely degenerated liver in toto and suspending it as much as 500 to 1000 c.c. of water can be obtained by drainage. In the patient presented to-night the gall-bladder was without bile. No bile was present in the gastro-intestinal tract, yet at the end of forty-eight to seventy-two hours after cholecystogastrostomy bile was present in the stomach. Within ten days the icteric index dropped to 67. This case may be one of opportunism and the patient on the way to recovery irrespective of what was done, but it seemed reasonable that we changed some of the hydrostatic mechanism of the liver and allowed hepatic regeneration to take place.

#### ACCESSORY PANCREAS SIMULATING GASTRIC ULCER—RESECTION

DR. CHARLES GORDON HEYD presented a woman, aged thirty-nine, who entered the Post-Graduate Hospital on November 12, 1926, complaining of flatulency, indigestion and pain in the right upper quadrant. The past history was negative. Physical examination and hospital studies suggested the tentative diagnosis of cholecystitis. The patient was operated upon, November 13, 1926, and the gall-bladder was negative on palpation and inspection. However, on the posterior surface of the pyloric ring and more particularly on the gastric side was a small penetrating ulcer with marked infiltration and induration. The appendix was found chronically diseased with a few adhesions, angulation and fecoliths. The operation consisted of a gastrotomy and visual inspection of the ulcer which was followed by a resection of the pylorus embracing one cm. of the duodenum and five cm. of the pyloric end of the stomach. By reason of the obesity of the patient it was deemed wise to close both duodenal and gastric stumps and do a posterior gastro-enterostomy. Patient took the anæsthetic badly and the immediate



## ANOMALOUS HEPATIC DUCT—PERICHOLECYSTITIS

post-operative course was somewhat stormy with considerable post-operative vomiting, necessitating gastric lavage on two occasions. From the third day after operation the patient, however, made an uneventful recovery and was discharged from the hospital on the seventeenth day after operation.

The interest in this case lies in the pathological report: "The specimen shows typical gastric pyloric glands, at the other end typical duodenal mucosa with Brunner's glands. Between the two the mucosa is thinned, although infiltrated with lymphoid cells and lymph nodules. Beneath this area are lobules of characteristic pancreatic tissue provided with interlobular ducts. These lobules of pancreatic tissue extend between the muscle bundles of the pyloric sphincter, in the deeper portions of which the ducts are much more conspicuous than the secretory alveoli. Dilated ducts can be traced into the serosa. In the two sections made through this area no actual communication between ducts and alimentary mucosa can be demonstrated." The pathological diagnosis was that of ulcerating aberrant pancreas, and chronic appendicitis.

## ANOMALOUS HEPATIC DUCT—PERICHOLECYSTITIS

DR. JOHN M. HANFORD presented a woman, age twenty-six, who was admitted to the Presbyterian Hospital in August, 1923. She had been ill three days with very severe pain in the right upper quadrant of the abdomen and with radiation of the pain to the back and right shoulder region. She had vomited and had chilliness. She had had frequent similar attacks for five years—that is since she was twenty-one. With one, she had been jaundiced. Morphine alone had given relief. She married at fifteen, and had had three children. She had not had typhoid fever. The past history was otherwise irrelevant.

The temperature and pulse were normal. The respirations were 46, probably due to pain. The urine was normal and showed no bile. The blood count was normal. She was operated upon three days later, under nitrous oxide-oxygen-ether. An upper right rectus incision was made.

There were adhesions between the fundus and body of the gall-bladder and adjacent viscera. In the region of the ampulla and cystic duct, the fibrous tissue was very dense and the structures here could be identified only by sharp dissection. All other viscera were found essentially normal. The appendix was not examined. There were no enlarged lymph-nodes and no evidence of distention of nor calculi in the ducts.

The exposure by chance was good. There appeared to be an unusually large cystic duct embedded in very dense tissue. After working upon it to free it, it was about to be clamped, when a separate structure running vertically in front of the cystic duct was identified. At first, it was thought a vein. After making a small opening into it, a vertebrated probe was passed in it up into the liver and upon the withdrawal of the probe, normal bile emerged. This structure was then accepted as the right hepatic duct running downward, separate from the common duct which it did not join as far as it could be traced behind the duodenum. This duct was about  $\frac{1}{2}$  cm. in diameter and had an indurated wall. It ran  $\frac{1}{2}$  cm. to the right of the common duct and nearly parallel to it. There were a few calculi in the gall-bladder. The opening was sutured; the cystic-duct freed and clamped; and the gall-bladder removed from duct to fundus.

After a relatively smooth uncomplicated course, she was discharged from the hospital on the eighteenth post-operative day and has shown a satisfactory follow-up result through nearly four years.

This woman owing to a duct anomaly came near to a fatality. After one fatality due to unexplained operative damage to the common duct, the reporter had never ceased to be uneasy working in the region of the ducts.

#### CALCULOUS OBSTRUCTION OF THE COMMON AND HEPATIC BILE-DUCTS

DR. RALPH COLP read a paper with the above title, for which see page 890, *ANNALS OF SURGERY*, vol. lxxxvi.

DR. ALLEN O. WHIPPLE said he thought it should be emphasized that the statistics given represent a cross-section of a general surgical service because, if one does not take that into consideration, and does not look into his own hospital statistics, one might think the results of operation in common duct obstruction discouraging. Doctor Whipple was sure that in any hospital where the cases are fairly analyzed the mortality in obstruction cases will be as high in proportion to cases in which the disease was limited to the gall-bladder as were those of Doctor Colp. The point to be emphasized is the difference in the mortality and risk of surgery where the disease is limited to the gall-bladder as compared with the disease when it has progressed beyond the gall-bladder into the duct system and the pancreas. In some 400 cases he had operated upon and subsequently followed, Doctor Whipple found there were 279, in which the disease was limited to the gall-bladder, in which there was no evidence of common duct or pancreas involvement. In 90 per cent. of these cholecystectomy was done and there was only one death. In the common duct cases where the disease had passed beyond the gall-bladder, the mortality jumped to 23 per cent. These figures included the cholangitis and the carcinoma cases.

The speaker felt it most important to stress the difference in risk, ease of operation and late results, in cases operated upon for disease limited to the gall-bladder and in those where the process had extended into the ducts and pancreas.

DR. RICHARD LEWISOHN stated that he agreed with Doctor Colp as to the dangers of general anæsthesia in cases of jaundice. He had performed a number of choledochotomies for common duct stones under local anæsthesia with very satisfactory results. During the last year he had used high spinal anæsthesia in this group of cases. The results were very gratifying.

DR. ALEXIS V. MOSCHCOWITZ stated that he was in absolute accord with almost every statement made by Doctor Colp. He would take exception, however, to Doctor Colp's condemnation of the procedure of dealing with the common duct without the introduction of a drainage tube directly into it. Many years ago, when surgeons were influenced by Kehr's teaching of the necessity of hepatic drainage, this was also the procedure practised by Doctor Moschcowitz. Subsequently, and at first tentatively, he sutured the incision into the common duct and when he found that these wounds healed very kindly, he adopted the procedure as a routine method.

DR. EDWIN BEER remarked that these studies place the surgeon in a dilemma as regards time of operation. His studies would indicate that the

## CALCULOUS OBSTRUCTION OF THE BILE DUCTS

earlier the operation, the better the results in obstructive jaundice. If this were the case it would lead surgeons to operate shortly after the onset, at a time when the stone may have passed into the duodenum, or perhaps at a time when the whole common duct is full of stones which would be very difficult to remove in such numbers, no matter how careful the surgeon might be.

DOCTOR BEER also felt that experience shows conclusively that cholecotomy drainage is absolutely essential, because often stones are overlooked, and at times stones are in the intra-hepatic ducts which are washed out during the after-treatment. In a series of such cases studied a few years ago in which the common duct stone had been removed and hepatic drainage instituted, fragments of stones, gravel and real stones had been recovered in a lavage of the biliary system. This point cannot be overemphasized too much, as in my study of 71 cases of cholelithiasis, 5 showed intra-hepatic stone formation. Practically all the cases of cholelithiasis with common duct obstruction due to stone showed regularly intra-hepatic stone formation. In a recent autopsy report from Russia, intra-hepatic stones were found in 25 per cent. of the post-mortems.

DR. FRANK S. MATHEWS reported two cases which he thought were probably cases of primary common duct stone formation. Case one had a cholecystectomy twenty years before, was well for nineteen years and then developed common duct symptoms. Six fascetted stones were removed. The second patient was thirty-eight years old. Her gall-bladder had been removed ten years ago and she had remained in good health until late in the course of a pregnancy which recently terminated. Just before and after the labor she had attacks of pain without jaundice. Operation revealed a single mulberry and cholesterin stone. It would seem as though a pregnancy eleven years after operation and the only one since operation had determined the stone formation.

DR. RALPH COLP, answering Doctor Moschcowitz, stated that Doctor Moschcowitz had done very few of these cases on the ward service and these results were represented mainly by the efforts of the younger men. The conditions of stone in the common bile-duct are not the same as in stone in the ureter, because there are two kidneys, and with the shut down of one, the other functions, and you do not have cessation of all function. With hepatic drainage in all these cases there was leakage in from four to five days, but in the meanwhile the spasm of the sphincter of Oddi had resulted in a damming back of bile with the deleterious effects of increased absorption. In regard to the point Doctor Beer made about the time of operation. In this series there was only one patient who was thought to have common duct obstruction and at the time of operation the duct was dilated, but the stone was not found.

## BRIEF COMMUNICATIONS

### ENTEROLITH SUGGESTING VESICAL CALCULUS

WE BELIEVE the case presented herewith should be reported for the following reasons:

(1) *The similarity of the X-ray shadow of the enterolith to that of a vesical calculus.* Unless one has in mind the possibility of enterolith, an error in diagnosis might easily be made.

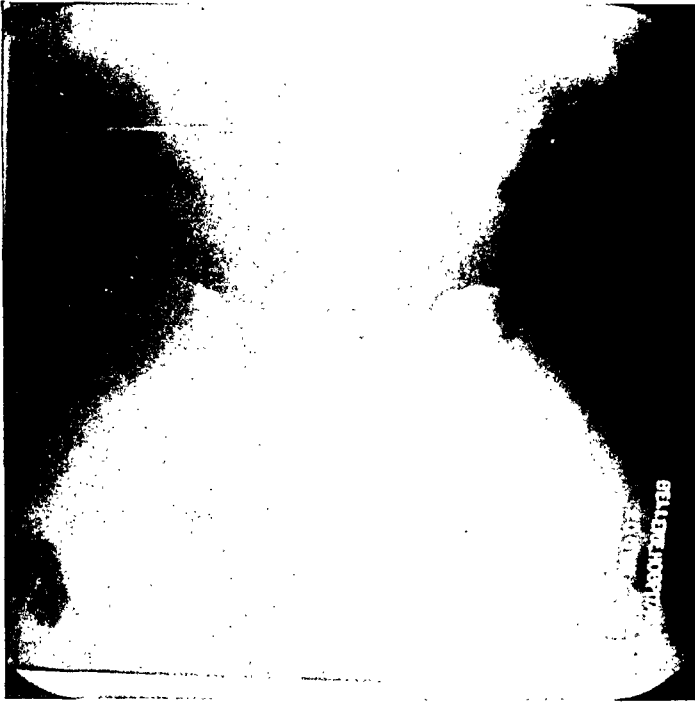


FIG. 1.—Shadow of enterolith. Except for the fact that it is hardly dense enough, it might be mistaken for a vesical calculus shadow.

In 1924, Childs<sup>1</sup> reported a large fecolith located in the rectum. The X-ray plates of his case showed a dense shadow which resembled that of a stone in the bladder.

(2) *The infrequent occurrence of enteroliths.* Gant,<sup>2</sup> in a complete review of the literature in 1901, collected 50 cases to which he added three of his own. We have been able to find only five reported since 1919.

(3) *The unusual size of the specimen.* Most enteroliths are quite small, varying in size from a pea to a walnut. Larger ones are seldom seen. The largest one ever found, according to Winterstein,<sup>3</sup> weighed 1500 grams.

CASE REPORT.—A male, aged twenty-seven, was admitted to the Bellevue Urological Department, August 14, 1926. The outstanding features of his past history were chronic constipation since early youth and an absolute dependence on laxatives to obtain a satisfactory bowel movement.

Two months before admission, he began to have pain of an intermittent type in the left lower quadrant. This pain would disappear after an efficient laxative had been taken. When constipated, there was also pain in the rectum. There were no urinary symptoms.

<sup>1</sup> Childs: Large Fecolith. *Radiology*, 1924, vol. iii, p. 261.

<sup>2</sup> Gant: Recto-colonic Enteroliths and Concretions. *The Post-Graduate*, 1901, vol. xvi, p. 335.

<sup>3</sup> Winterstein: Ueber Enterolithen. *Deutsch. Zeitsch. f. Chirg.*, 1925, vol. cxci, p. 409.

# ENTEROLITH SUGGESTING VESICAL CALCULUS

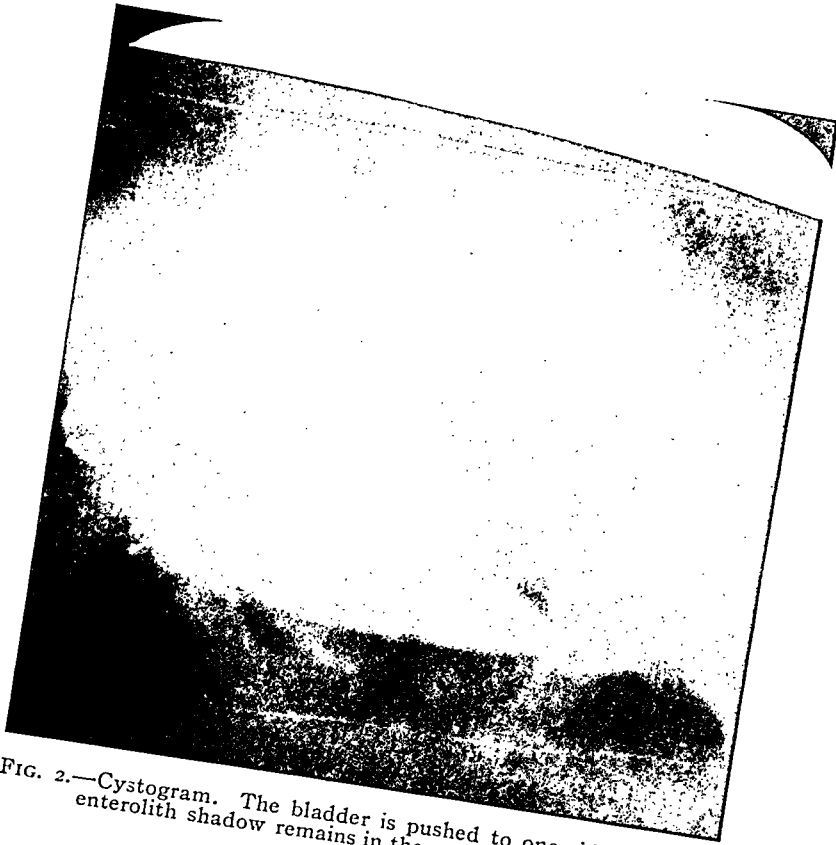


FIG. 2.—Cystogram. The bladder is pushed to one side, while the enterolith shadow remains in the centre of the pelvis.

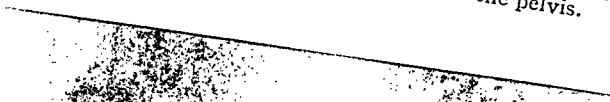


FIG. 3.—X-ray after barium enema. Note marked dilatation of sigmoid.

Physical examination disclosed in the left lower quadrant of the abdomen a large indistinct mass, insensitive to pressure and somewhat movable. By rectal palpation, there was a globular mass, immediately inside of the sphincter and separated from the examining finger apparently only by the rectal wall. With the other hand above the pubis during rectal palpation, the globular character of the mass could also be determined bimanually, slight ballottement being possible. The prostate gland was apparently normal. Urine analysis: Negative.

The patient was X-rayed. The radiographer reported, "The whole pelvis is occupied by a rounded calcareous mass suggesting vesical calculus." (Fig. 1.)

A cystogram with 6 per cent. sodium iodide was next made. Radiographer's report:

"Cystograph examination reveals a moderate-sized viscus displaced to the left; the outline is normal." (Fig. 2.)

Cystoscopic examination showed a normal bladder mucosa with the left bladder wall inverted as if a large rounded mass were pushing it in from without. A proctoscopic examination of the rectum was negative.

X-ray after the administration of a barium enema showed, according to the radiographer—"marked dilatation of the sigmoid flexure and descending colon"; also "a marked pressure defect in the sigmoid flexure corresponding to the mass previously described." (Fig. 3.)

By virtue of a certain routine examination which

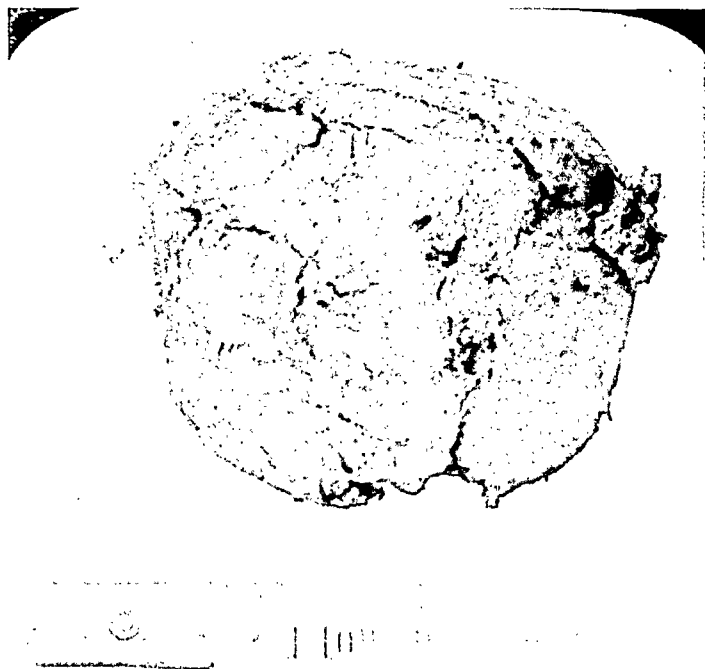


FIG. 4.—Photograph of section of enterolith. The scale is in centimetres.

many of our cases undergo immediately on admission, the radiographer's report, together with the film (Fig. 1) were submitted to us, before a general physical examination of the patient had been made. The symmetrical position of the shadow with regard to the bony pelvis almost forced upon us the diagnosis of vesical calculus, although the shadow seemed entirely too "thin" for a stone of such size. However, the negative urine, together with the negative cystoscopic findings, soon led us to eliminate the urinary tract. The radiographic results with the barium enema, the cystogram and general physical findings, enabled us to make the correct diagnosis of enterolith. The patient was accordingly transferred to the Second Surgical Division where he was successfully operated upon by Dr. H. M. Bergamini. By means of an intraperitoneal operation, he found the enterolith in the lower portion of the sigmoid. After removing the obstructing mass, the gut was sutured. The peritoneum was drained.

The patient was discharged from the hospital in good condition on the thirty-fifth day after operation.

Gross examination of specimen: Uniform throughout with slight lamellation at the periphery. Many small crystals could be discerned, by their reflection, throughout the mass. (Fig. 4.)

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## PRIMARY CARCINOMA OF THE HEPATIC DUCT

### PRIMARY CARCINOMA OF THE HEPATIC DUCT

Primary carcinoma of the hepatic duct is rare. Rolleston, in a careful search, was able to collect only twenty-two cases, involving this portion of the biliary system. It is because of its comparative rarity that we add this case to surgical literature.

The patient, a white male, age seventy-three, was referred by Dr. Samuel O. Kemp of this city. He complained of a persistent painless deepening jaundice of about four weeks' duration. The past history was not remarkable. There were no gastro-intestinal symptoms and no history of gall-stones. During the previous two or three weeks the patient complained of general weakness, but was not aware of any loss in weight.

Physical examination showed a well-developed elderly man with marked jaundice. The temperature, pulse and respirations were normal.

The lower edge of the liver was palpable about three inches below the costal margin and liver dulness extended to the fourth interspace on the right side. Both the right and left lobes were apparently enlarged. There was no swelling of the lower extremities and no free fluid in the peritoneal cavity.

The urine was dark green in color and gave a positive test for bile pigment; it also contained albumin and casts. The stools were clay-colored and contained many fat globules. The coagulation time of the blood was not increased, ranging from four to five minutes. Blood sugar 88 mg. and N.P.N. 24 mg. The Wassermann reaction was negative.

A provisional diagnosis of carcinoma at the head of the pancreas was made and operation advised. This was subsequently done under local anesthesia with the following operative findings:

The liver is diffusely enlarged, extending almost to the umbilicus. The gall-bladder is somewhat distended and empties with difficulty. There is no evidence of gall-stones in the gall-bladder nor cystic duct. The head of the pancreas is not enlarged and there are no palpable portal lymph-nodes. No stones are felt in the common duct but the hepatic duct seems somewhat thickened. On account of the age of the patient and his poor general condition further operative interference was thought to be contra-indicated. The gall-bladder was drained and the wound closed with interrupted silk sutures.

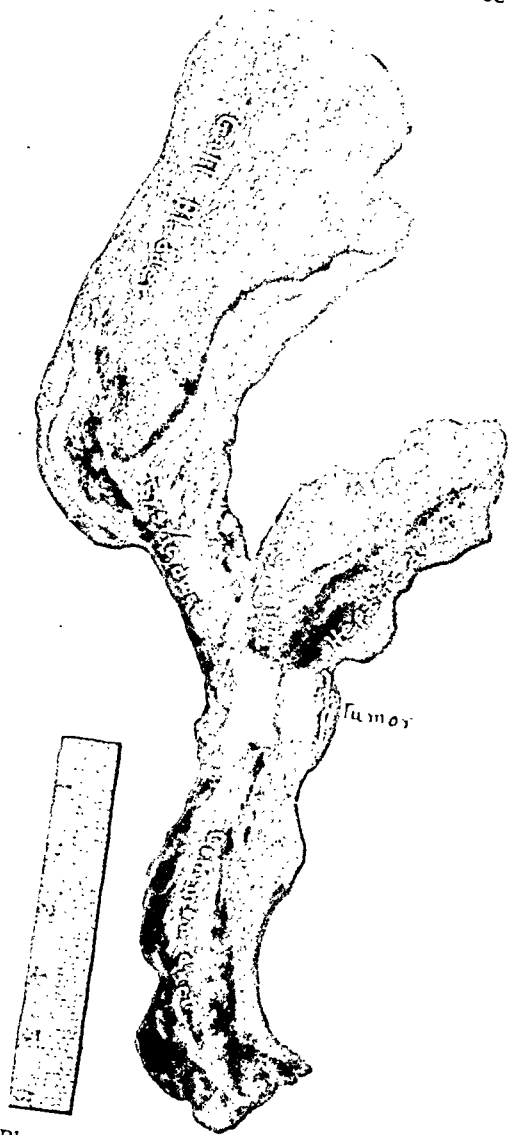


FIG. 1.—Photograph of gall-bladder and bile-ducts showing the tumor in the terminal portion of the hepatic duct.

## BRIEF COMMUNICATIONS

Following this there was scant drainage from the gall-bladder averaging from one to four ounces a day.

On the fourth day after operation the patient developed a broncho-pneumonia with signs of cardiac failure and expired four days later.

We are indebted to Doctors Jacobson and Waddell for the autopsy findings and quote verbatim from their report.

"Liver: weight 2100 gms. It is diffusely enlarged, and the edges are much rounded. The lobules are outlined beneath the capsule by deep green lines about yellowish-brown lobules. On section there is very great dilatation of the intrahepatic

bile-ducts which are filled with a pale greenish fluid. The lobules are outlined by greenish lines. As the hepatic ducts are disclosed they become progressively dilated toward the hilum where they emerge as the right and left chief ducts which are fully one cm. in diameter and filled with thin pale green fluid. No stones are found in any of the ducts. See photograph (Fig. 1).

"Opening the hepatic duct discloses a mass of white tissue, firm, and which does not move on manipulation, which appears to obstruct completely the lower end of the hepatic duct. This growth is about  $2 \times 1.2 \times 1.5$  cm. in size and a probe can be passed through it with great difficulty. It has a finely nodular surface and springs rather abruptly from the duct lining. It extends to involve a few millimetres of the upper end of the common duct also.

"The cystic duct opens just below the growth, but it is doubtful if its ostium was functionally open, as it is in such close proximity to the tumor. The common duct is very slightly dilated also, but there are no stones to be found. The ampulla is of slightly increased prominence but otherwise normal.

FIG. 2.—Low power photomicrograph of longitudinal section of tumor. Showing invasion of tumor cells still preserving an acinar structure extending to the adventitia and the marked fibrous reaction.

"The gall-bladder has been opened at its tip for surgical drainage. Its walls are thickened moderately, mucosa pale and reddened. No stones present. At operation it is said it was distended with pale colorless fluid. The cystic duct is not dilated."

"The tumor is an adenocarcinoma of the hepatic duct, apparently arising in its mucosa, growing upward to obstruct the lumen and downward to cause much thickening of wall. It has penetrated to the fatty tissues about it which it has also invaded. The tumor has produced considerable reaction in stroma where there is a fairly abundant connective tissue."

Attention is called to the marked dilatation of the duct system above the tumor mass, which extends well into the liver substance. The tumor is relatively small with



## CAUTERY-PNEUMECTOMY

no signs of metastasis; the usual signs of malignancy are absent, the symptoms being due to the strategic location of the tumor producing the signs of an obstructive jaundice.

EDGAR A. VANDER VEER, M.D.,

HOMER L. NELMS, M.D.,

*Albany, N. Y.*

## CAUTERY-PNEUMECTOMY

The technic of cautery-pneumectomy, described by Dr. Evarts A. Graham, in the *ANNALS OF SURGERY* of August, 1927, p. 178, appears to be identical with that of the operation devised by Professor Gluck, and performed by another surgeon at Professor Gluck's suggestion, nineteen years ago. The operation was performed for threatened asphyxia, caused by compression of the trachea by a mediastinal tumor. The operation demonstrated the possibility of retrograde respiration. Professor Gluck, writing from Berlin, November 15, 1908, kindly gave me the following details:

Two or three ribs (sixth to eighth) are resected in the posterior axillary line. The two layers of pleura are sutured together, inclosing an area of lung surface the size of a man's hand. A fortnight later, or at once if the case is urgent, the lung is burned away with a cautery, until the opened ends of a number of the smaller bronchi are exposed in the cauterized surface. The cauterization may be made sufficiently deep to expose the larger bronchi, but this is not necessary.

The operation may be repeated on the opposite lung, if required. The aims of the two operations differ, that of Professor Gluck's being to let air in, that of Doctor Graham's to let pus out.

C. HAMILTON WHITEFORD, M.R.C.S., L.R.C.P.,

*Plymouth, England.*

## BOOK REVIEW

TESTIMONIAL TO DR. RAFFAELE BASTIANELLI, of Rome, Italy, by his pupils and friends on the 25th anniversary of his Professorship in Surgery. A collection of surgical articles written in honor of Dr. Raffaele Bastianelli, published in the Italian Archives of Surgery, in its XVIII Volume (1927). The contributions are from one hundred and five Italian physicians and surgeons, some of them old pupils of Professor Bastianelli, the rest old friends and admirers, beside twenty-five more friends and admirers from foreign countries.

The volume is of over 700 pages. It is perhaps the first time that an international work of this kind is done in honor of a man, who, being well known and popular through the professional world, fully deserves it for his constant and valuable contributions to the progress of surgery.

Most interesting are the articles of F. H. Albee on "Extra-articular Arthrodesis in Tuberculosis of the Spinal Vertebrae, of the Hip-joint and the Sacro-iliac Joint." That of W. J. Mayo on "Surgical Diseases of the Spleen"; that of E. Starr Judd on "Cholecystitis"; that of E. Beer on "Clinical and Pathological Analogy between the Urinary and the Biliary Tract"; that of J. C. Bloodgood on "Duodenal, Acute and Chronic Dilatation, and the Gastro-enteric Ileum" and Vincent Gaudiani on "How to Deal with the Ureter in Its Extravesical Insertion."

Among other contributions of foreigners is one from Sir Berkeley Moynihan, of England, on "Perforations of Gastric and Duodenal Ulcers"; one of V. Pauchet, of France, on "How to Treat Gastro-intestinal Hemorrhage" and "Excision of the Ulcer and Cæcostomy"; one of R. Leriche on the "Section of Communicating Branches in Painful Manifestations of the Limbs"; one of P. Duval on the "Part Played by Infection in the Evolution of Some Gastro-duodenal Ulcers and Its Therapeutic Indications". The volume, beside its commendable purpose of a testimonial to Dr. Raffaele Bastianelli, is also a very valuable contribution to the scientific and practical progress of medicine and surgery.

PAOLO DE VECCHI.

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## COLONIC ANÆSTHESIA IN OPERATIONS UPON BRAIN AND SPINAL CORD \*

BY CHARLES H. FRAZIER, M.D.

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INTRODUCTION.—Muller's well-written paper on the "Changing Status of Anæsthetics" (ANNALS OF SURGERY, August, 1927), as the title implies, emphasizes the present unsettled state in the selection and popularity of anæsthetics. From that historical date 1846, there have been many shifts from one anæsthetic to another, chloroform to ether, to nitrous oxide, to ethylene, spinal and splanchnic, regional and local. And during these transitional periods, or really almost at the beginning, Pirogoff (*Recherches pratiques and physiologiques sur l'etherization*, St. Petersburg, 1847) proposed the introduction of ether into the rectum. In the same year others reported their experiences with the injection of ether, pure, or in aqueous solution. For some reason or other there was a lapse of interest from 1847 until 1884 when Molière (*Lyon Medical*, p. 45, 1884) revived colonic anæsthesia, first with ether vapor forcibly injected. Again another period of disuse from 1884 to 1903 when Cunningham (*Boston Medical and Surgical Journal*, vol. clii, p. 450, 1905) proposed the addition of oil as a vehicle for carrying the vapor into the intestine, perhaps stimulated by Sutton's experience with 140 cases at the Roosevelt Hospital. During the next ten years many surgeons gave colonic anæsthesia a trial and in 1913 Gwathmey presented to the International Medical Congress in London (*Lancet*, December 20, 1913) the results of his observations in the experimental animal of the combination of oil and ether. From these experiments it appeared, regardless of whether one used animal, vegetable or mineral oil, no matter what per cent. the mixture, the rate of evaporation remained constant. The charts of the experimental animal demonstrated quite conclusively that as the ether is evaporated slowly it must be absorbed slowly. The significance of these experimental observations is twofold: in the first place there is an even plane of anæsthesia; secondly, the administration of ether oil colonically is a safe procedure. This, only by way of a very brief introduction.

My first experience with colonic anæsthesia was in April, 1927. On a previous attempt at removal of a deep-seated cerebral tumor, under general ether narcosis, the patient seemed intolerant to ether. Rather against our

\* Read before the Philadelphia Academy of Surgery, November 7, 1927.

# CHARLES H. FRAZIER

better judgment ether narcosis was substituted for local anæsthesia, and although there was little in the operative manipulations at that particular sitting to account for it, the pulse rate almost from the beginning was exceedingly rapid and throughout the operation the rate was recorded for the most

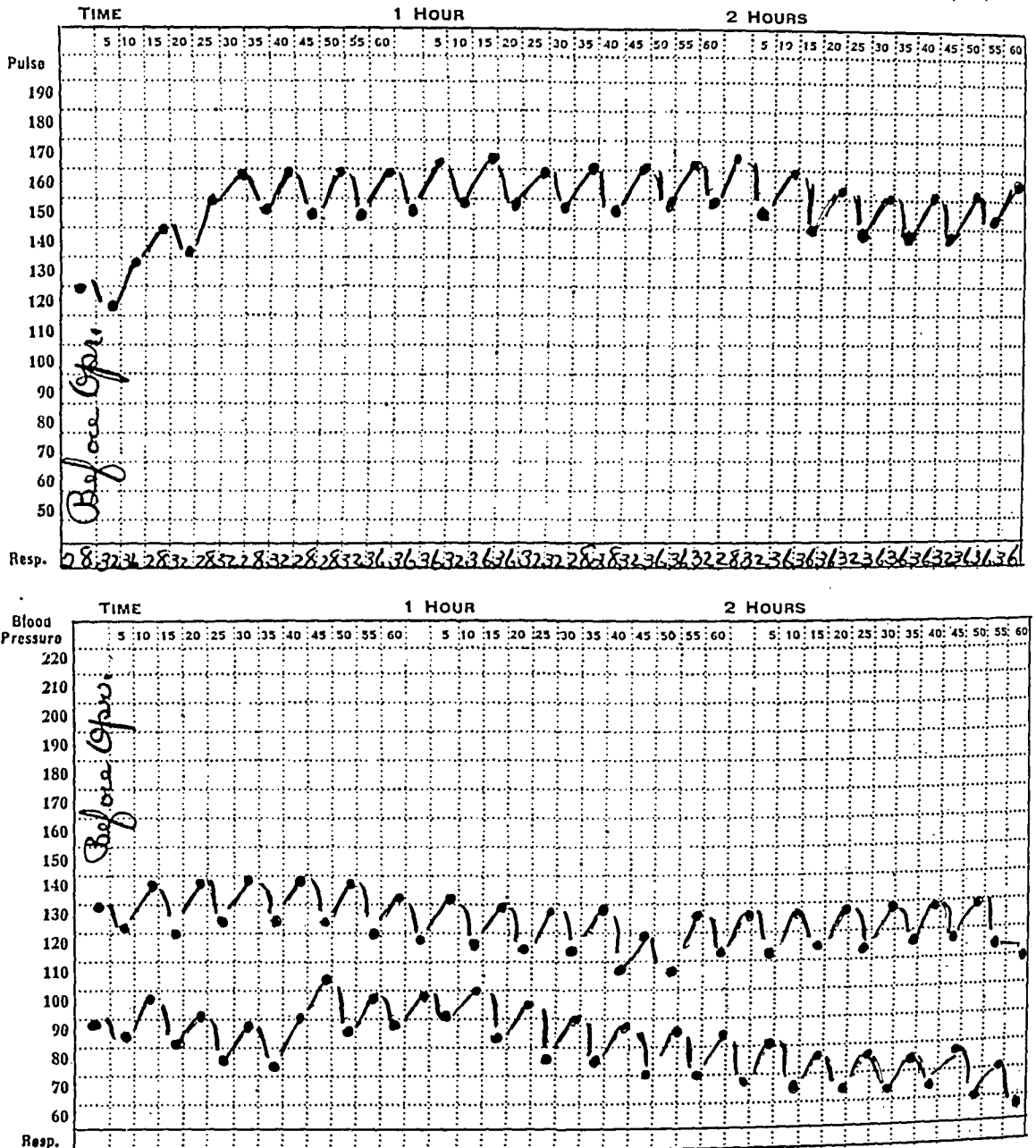


FIG. 1a.—A. H. C. Operation, second stage craniotomy, February 2, 1927. Operator Doctor Frazier. Operation started 9.10 A.M. Operation ended 12.10 P.M. Anæsthetic, local and ether. Open method. Anæsthetizer L. A. Hitz. Total amount used, ether iv oz. A. S. gr. 1/150 B. Anes. Patient fair condition.

part as between 160 and 170. Naturally, I was disturbed and uneasy and when at the next sitting the selection of the anæsthetic was discussed, my anæsthetizer, Miss Leta Hitz, proposed colonic anæsthesia. It was employed with entire satisfaction and if one compares the pulse curves of the two operative sittings (Fig. 1a and Fig. 1b), at once admits a striking demon-

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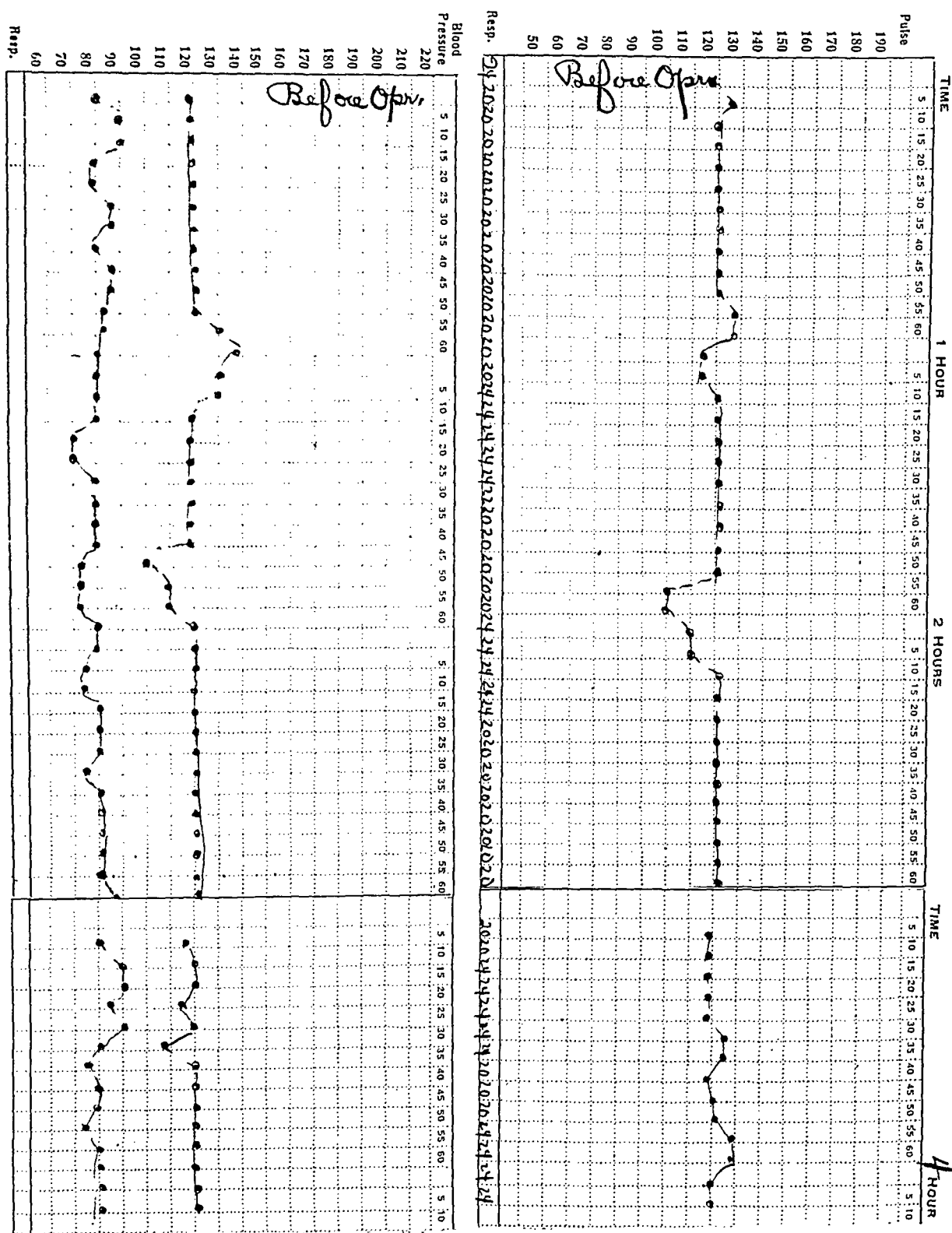


FIG. 1b.—A. H. C. Operation, third stage craniotomy, removal of tumor, April 25, 1927. Operator Doctor Frazier. Anæsthesia started 8.45 A.M. Operation started 9.35 A.M. Operation ended 1.30 P.M. Anæsthesia—colonic. Anæsthetizer L. A. Hitz. Total amount used, ether oz. vi, olive oil oz. iv, 8.45 A.M.—A. S. gr. 1/150, 8.15 A.M. No inhalation anæsthesia. Patient good condition.

stration in favor of colonic over inhalation narcosis. Since this initial experience, colonic anæsthesia has been employed in my clinic seventeen times, in twelve operations by myself and in five operations by my associate, Dr. Francis C. Grant. These operations included for the most part craniotomies with removal of brain tumors, suboccipital craniectomies, subtemporal decompressions, laminectomies.

*General Considerations.*—It is apparent that colonic anæsthesia by one method or another has had its ups and downs. So far as I know, the application of colonic anæsthesia to operation on the cerebrospinal tract has never been seriously advocated and I must confess were it not for the suggestion and the efficiency of my anæsthetizer, Miss Hitz, I would not have given it a moment's thought. One can readily understand why the abdominal surgeon might have found objection, chiefly in that muscular relaxation was not always adequate, and as this for him is a *sine qua non*, naturally the method fell into disuse. In operations upon the cerebrospinal system, operation requires a state of negative existence, if I may use that term, a negative state of the ego; something which will suppress apprehension, carry the patient through the tedium and the physical discomforts of the fixed position on the operating table for the two or more hours of the neurosurgical operation. It is not analgesia in the ordinary sense that to my mind is the object of the colonic anæsthesia. One can readily desensitize the tissues in all cranial procedures with novocain so that every step of the operation is painless. Neurosurgical operations more than any others lend themselves to local anæsthesia; the easily desensitized scalp, the painless skull, the dura, the brain—it's all a very simple process. You may ask, if one wants only to obtund the mental sensibilities why not use opium or its derivatives? Merely because there are certain recognized contra-indications to morphin in the neurosurgical clinic. In fact, in most instances we regard morphin as taboo. Hence there is a very real need for some therapeutic agency which induces sleep and at the same time depresses neither the circulatory or respiratory mechanism—some agency which will induce a tranquil state. There are patients and patients; in the case of a perfectly phlegmatic subject almost any operation on brain or cord can be carried out under local anæsthesia and, as a matter of fact, the majority of operations in my clinic are carried out with novocain-adrenalin infiltration. But in the case of children, with certain apprehensive women and even some men, we welcome any remedy which will negative their reaction to apprehension or fear and ensure absolute physical rest.

We must recognize such a thing as psychic shock. The emotion of fear is not without its deleterious effect. To cite you an instance: several years ago a physician was about to be transferred to the operating room for a cranial operation. He was exceedingly apprehensive, as many physicians are, and he arrived at the operating room with a systolic blood-pressure of 70 mm. Hg. After the preliminary incision the systolic pressure had not risen and I at once abandoned any thought of continuing the operation and

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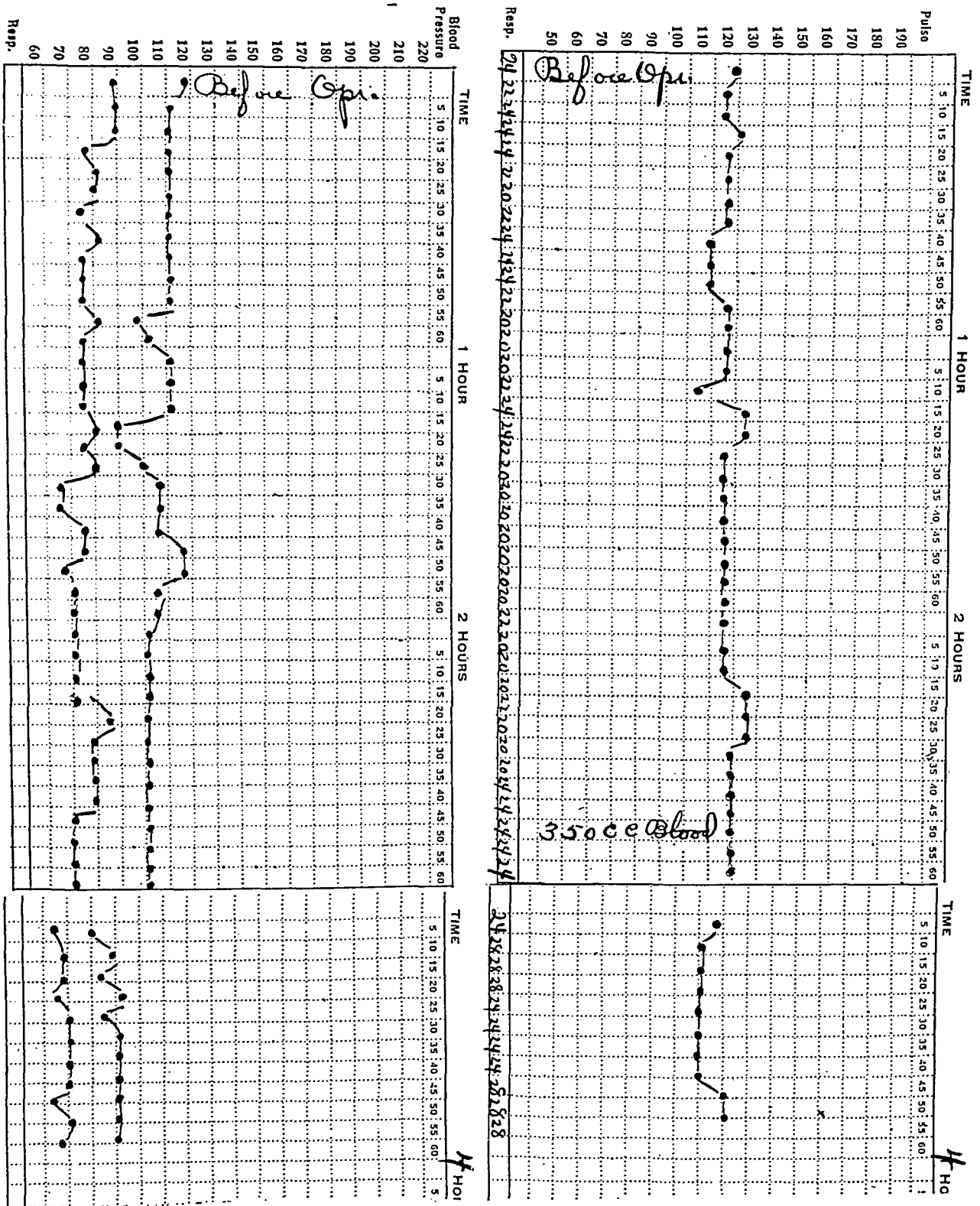


FIG. 2.—Mrs. E. E. P. Operation, right craniotomy, removal of tumor, May 16, 1927. Operator Doctor Frazier. Operation started: 9.20 A.M. Anæsthesia, 8.15 A.M. Operation ended 1.10 P.M. Variety—ether. Method colonic. Anæsthetizer L. A. Hitz. Time to anæsthetize, 1 hour 5 minutes. Amount ether, oz. vi, olive oil, oz. iv, scopolamine gr. 1/200—7.30 A.M., A. S. gr. 1/150. Patient good condition.

sent the patient to his room. It was several days before he reacted. A week later his blood-pressure was normal, his apprehension had been allayed and he passed through the operation without any recurrence of his previous experience.

So many patients in our Neurosurgical Clinic are operated upon in the face-down position, and merely as a matter of convenience, although this is a minor consideration, colonic anæsthesia has its advantages.

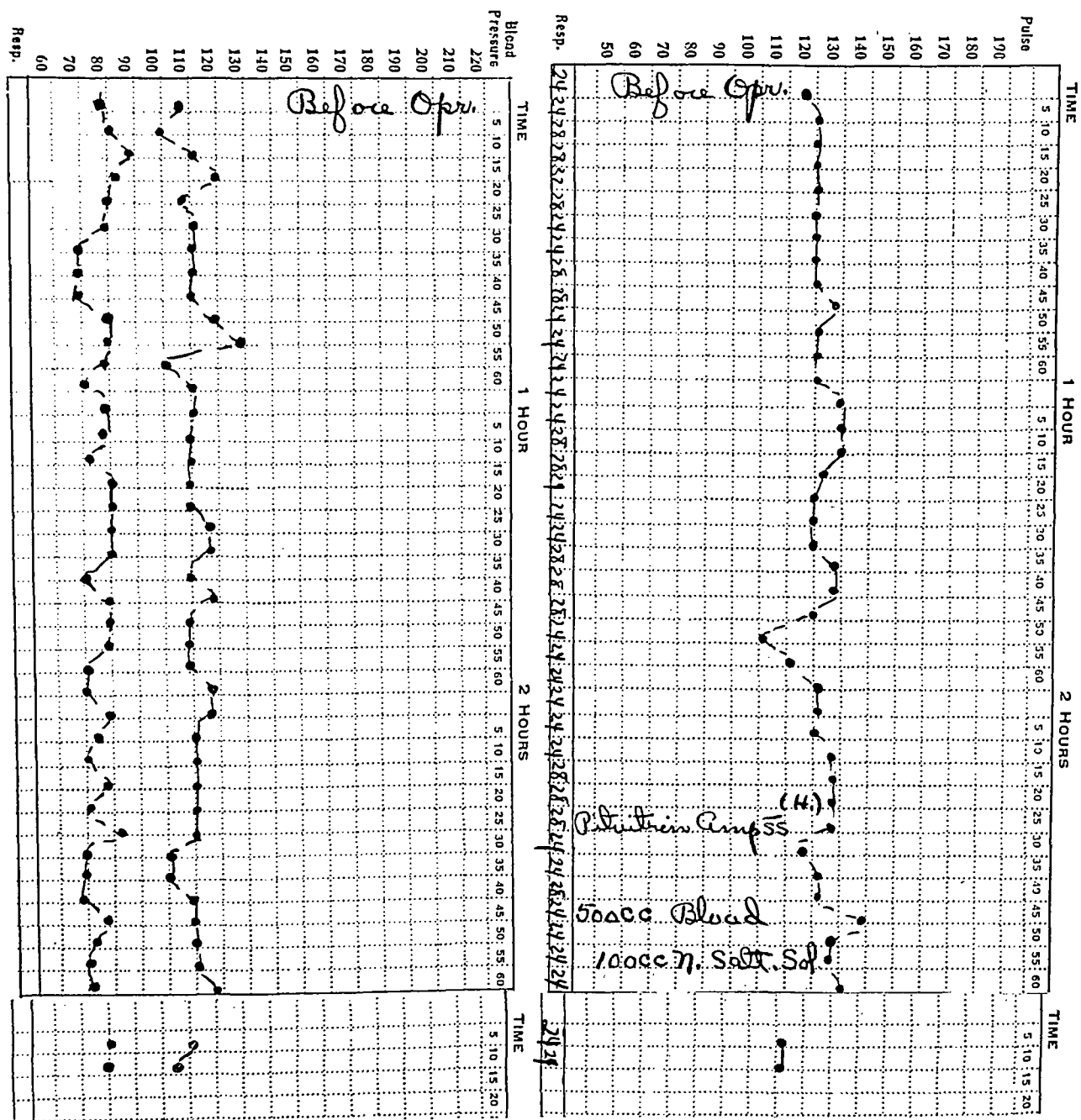
I shall not attempt a categorical review of the advantages and disadvantages of colonic anæsthesia. Perhaps of more value and interest would be a brief statement as to my personal reaction.

In the first place, as to its relative safety: we have followed strictly the prescribed dosage and have not seen a suggestion of any toxic effects. There have been a few instances in which it has been necessary to supplement with ether by the inhalation method. Personally, I prefer when necessary, to supplement by inhalation rather than introduce an additional amount into the colon. The latter would be inconvenient while the operation was under way and too much ether introduced into the bowel is not without risk. I think I may say, with entire truth, that at no time in this small series of operations have I had any cause for alarm from the standpoint of anæsthesia. If one wants more specific evidence of the safety of the method, the presentation of the pulse and blood-pressure charts meet the requirements. Here, for example (see Fig. 2) is the chart of a patient past middle life from whom a cerebral tumor was removed. The operation, a craniotomy, lasted almost four hours and you can see at a glance, with a few short and slight variations, how constant the rate of pulse and blood-pressure remained. As an example of an operation in another field, I might exhibit (Fig. 3) the chart of a case in which a cerebellar tumor was removed. As a rule in cerebellar procedures we expect, because of proximity of the brain stem, not only greater fluctuations in pulse and pressure, but marked acceleration in the pulse rate and a decline in systolic pressure as the operation proceeds. In this instance it will be noted the pulse rate was 120 at the beginning, and 120 at the close of a three-hour ordeal, the pressure was 110/80 at the beginning and 110/80 at the conclusion. That in some instances colonic anæsthesia must be supplemented with ether by inhalation is not a very serious objection, although under these circumstances the method does not so nearly approach the ideal. The next chart was made during a suboccipital craniectomy for cerebellar tumor. In this case four ounces of ether were given by inhalation, the pulse rate at the beginning was 125, at the close 110; blood-pressure at the beginning was 120/80 and at the close 120/80 (Fig. 4).

The operation in which, in my experience, colonic anæsthesia seems to have its outstanding indication is laminectomy. It is virtually impossible to complete the operation painlessly under local anæsthesia. Baring the spinous processes is of necessity painful and the manipulations, within the dural sac, with the accompanying traction on the posterior roots, of course excites pain. In my limited series there were several laminectomies and one chart will



# COLONIC ANÆSTHESIA IN OPERATIONS UPON BRAIN



suffice by way of illustration. The subject was a patient past middle age, who was not altogether a good operative subject. (Fig. 5.) Before the wound was finally closed four hours elapsed, but at no time did the patient's condition give us the slightest cause for anxiety. Six ounces of ether were introduced into the colon and toward the close of the operation four ounces were given by inhalation. Pulse and blood-pressure curves speak for themselves.

From the standpoint of the comfort of the patient, the unpleasant sense of suffocation that often accompanies ether inhalation is avoided. The patient is in an analgesic state for several hours after the operation and post-operative pain is thereby prevented. Furthermore, post-operative nausea is reduced to a negligible degree.

Post-operative pneumonia after operations upon the brain is with us so rare a complication that it cannot be used as a criterion to judge of the advantages of colonic over inhalation anæsthesia. But emphasis might be laid on the fact that in colonic anæsthesia the patient always inhales a warm moist vapor. In its passage through the small vessels of the colon, through the liver and heart to the lungs, the ether is moistened and warmed to body temperature so that in the induction of anæsthesia and in its maintenance, there is no irritation of the upper air passages and bronchi and no resulting secretions. This absence of irritation suggests an advantage of colonic over inhalation anæsthesia in patients with pulmonary tuberculosis and as a matter of fact in the second case of our series colonic anæsthesia was given preference for this reason. The fact that ether can be absorbed by the colon only at a fixed rate, about two ounces per hour, is another factor of safety. Anæsthesia is automatically maintained, according to Gwathmy, because there is a constant rate of ether evaporation from the oil, regulated by the temperature of the colon; the cooling of both the mixtures and gut during evaporation retards both elimination and absorption. Again the difference between the ether absorption power of the colon and the elimination capacity of the lungs provides another safety factor.

Thus in colonic anæsthesia we have a method of inducing narcosis in which there is none of the sense of suffocation, no period of excitement, no harmful influence upon pulse or blood-pressure, no irritation of the upper air passages, a state of analgesia after consciousness has returned, a narcosis of uniform depth, the ether vapor is always warm, there is less post-operative nausea and vomiting, the amount of ether in the system is a fixed known quantity.

The technic of administration as adopted by Miss Hitz is as follows:

Castor oil fluid ounce I on two successive nights preceding the operation.

Luminal grains I on the night before operation.

Soap and enema followed by a colonic irrigation on the morning of operation.

One hour before the operation the patient is sent to the etherizing room, where absolute quiet must be observed, and is given by bowel two drachms of

# COLONIC ANÆSTHESIA IN OPERATIONS UPON BRAIN

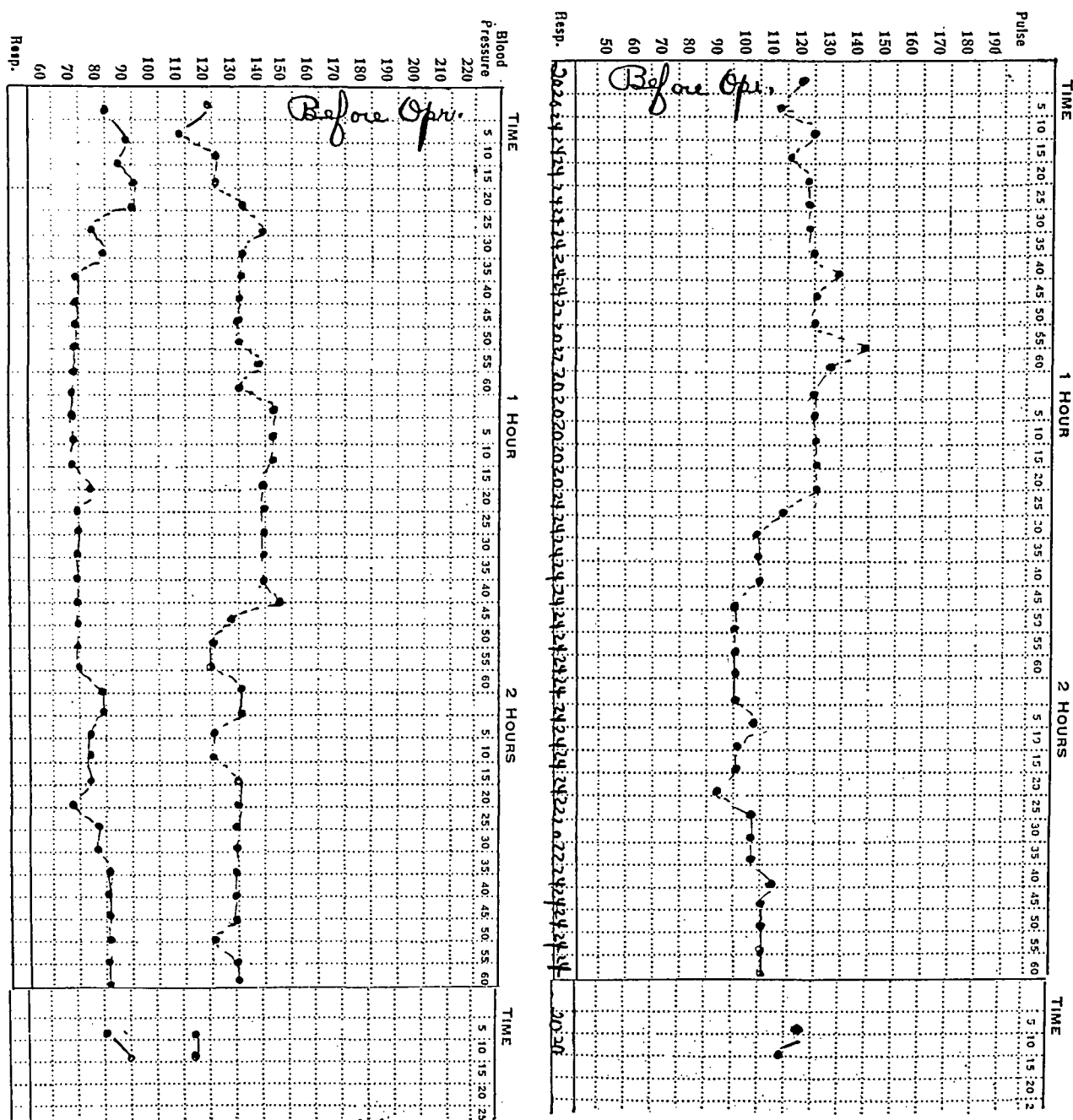


FIG. 4.—E. C. Operation, suboccipital craniectomy, September 17, 1927. Operator Doctor Frazier. Operation started: anæsthesia 8.10 A.M., operation 9.30 A.M. Operation ended 12.40 P.M. Variety—colonic anæsthesia. Anæsthetizer L. A. Hitz. Amount inhalation ether oz. iv, 8.10. Ether viii oz., oil iv oz., scopolamine gr. 1/100. Patient good condition.

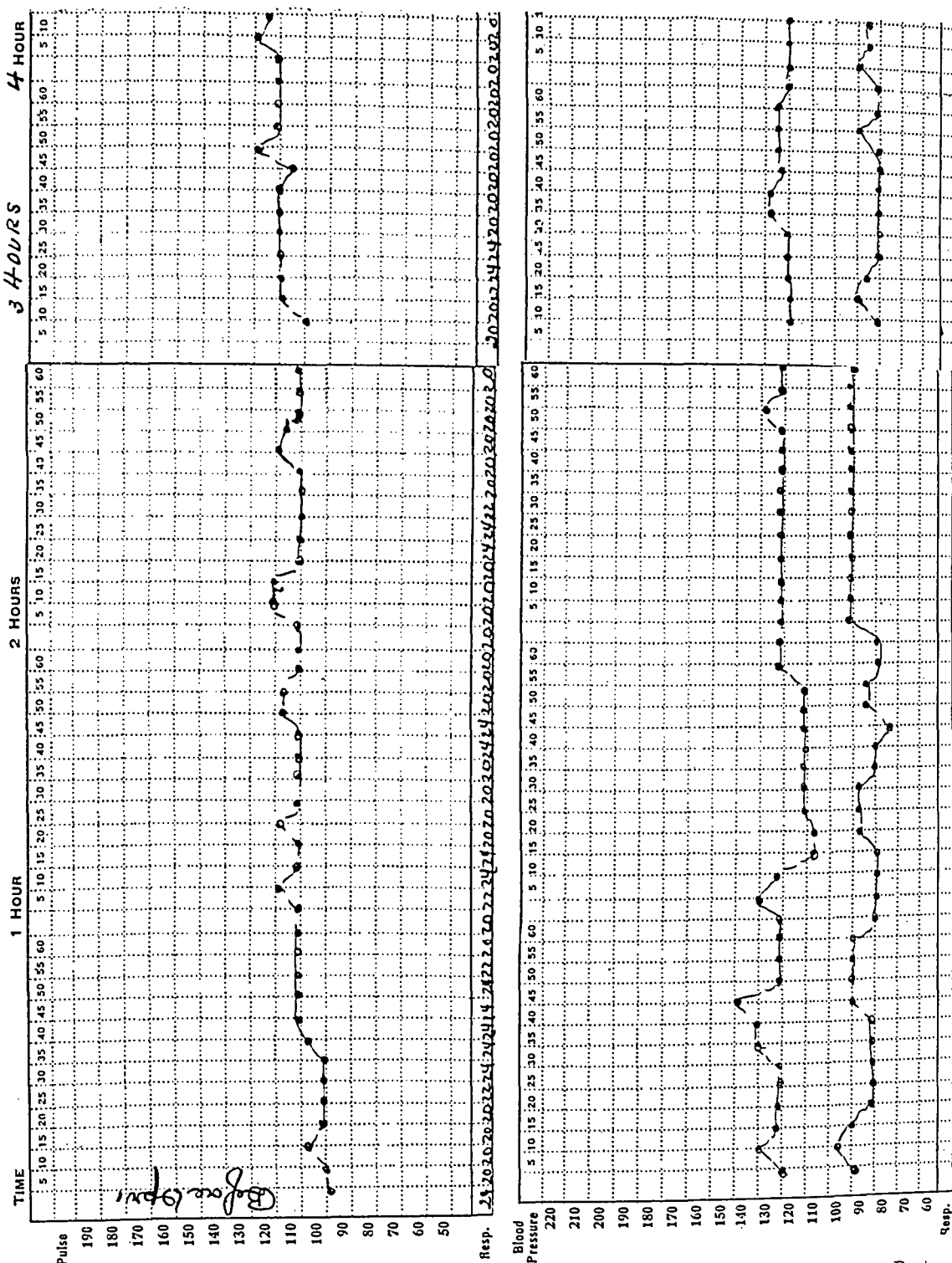


FIG. 5.—K. McK. Operation, laminectomy, tumor exposed but not removed, June 23, 1927. Operator Doctor Frazier. Operation started: anæsthesia 8.00 A.M., operation 9.00 A.M. Operation ended 12.30 P.M. Variety—colonic anæsthesia. Anæsthetizer L. A. Hitz. Inhalation oz. iv. Amount oz vi, ether, oz. iv olive oil, Pituitrin amp. ss., M. S. gr.  $\frac{1}{4}$ , A. S. gr.  $\frac{1}{150}$ . 7.30 A.M. Patient good condition.

## COLONIC ANÆSTHESIA IN OPERATIONS UPON BRAIN

paraldehyde, one-half ounce each of olive oil and ether in which five grains of chloretone have been dissolved. This mixture is introduced very slowly, the rectal tube is clamped for a few moments, then withdrawn.

One-half hour before the time set for the operation, unless contra-indicated, morphine grains one-sixth and atropin grains  $1/150$ th are given hypodermatically and at the same time the balance of the ether-oil mixture. With the patient on his left side, one fluid ounce of a 65 per cent. solution of ether in olive oil for every 20 pounds of body weight is allowed to flow slowly from a funnel into the rectal tube. This amount, however, should not exceed eight fluid ounces. The rectal tube is clamped and left *in situ*.

At the conclusion of the operation what remains of the mixture in the bowel is drained off, and after irrigating the bowel with one pint of warm water, four ounces of olive oil with from four to eight ounces of black coffee are introduced and the rectal tube withdrawn.

Care must be taken during the operation to see that the mouth and nose are in no way obstructed so that breathing is not impeded.

In the case of children no preliminary treatment is required save atropin and the amount of ether should not exceed one fluid ounce per twenty pounds of body weight.

# DIFFERENTIAL SECTION OF THE TRIGEMINAL ROOT IN THE SURGICAL TREATMENT OF TRIGEMINAL NEURALGIA<sup>1</sup>

By BYRON STOOKEY, M.D.

OF NEW YORK, N. Y.

IN THE development of the surgical treatment of any disease the principle of evolution with its additions, subtractions, trial and error is not infrequently seen, usually with a constant trend toward greater specialization in the procedures used. Archaic methods, however, remnants of a former

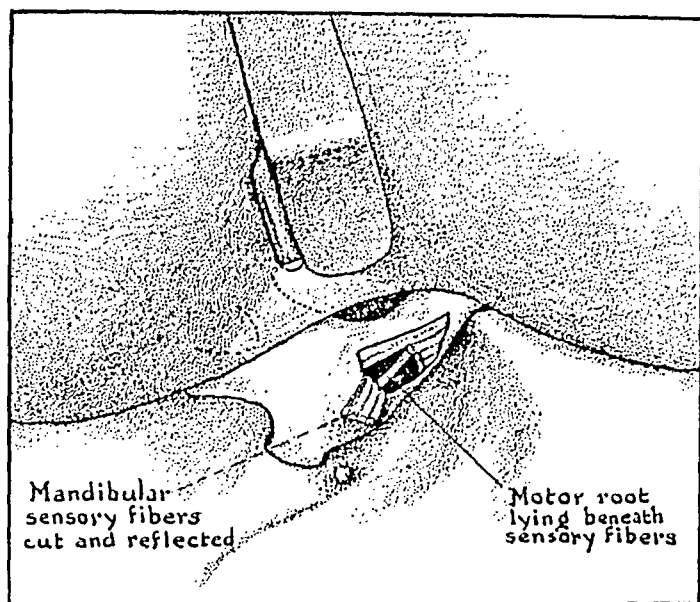


FIG. 1.—Differential section of the trigeminal neuralgia limited to the mandibular division. The sensory fibres of the dorsal root derived from the mandibular division are cut without cutting the maxillary or ophthalmic fibres. The motor root lying beneath the sensory root is identified and saved.

age, are frequently adhered to by the profession at large, long after they have been proved obsolete by those working more intensively in the particular field. Section of the nerves within the skull distal to the gasserian ganglion, operations on the peripheral branches, alcoholization of the gasserian ganglion, and of the branches, and total section of the trigeminal roots, both motor and sensory, are among such archaic methods, though

there are exceptional instances when some of these procedures may still be indicated.

In the evolution of the surgical treatment of trigeminal neuralgia there have been a number of refinements of procedure, the most important of which was the substitution of complete section of the dorsal root for the older procedure of removal of the gasserian ganglion—an advance suggested by Spiller and first carried out by Frazier. The method suggested by Spiller was generally adopted in this country until further refinements in the procedure were developed by Dr. Charles Frazier, who saved first the motor division, while cutting all of the sensory root, and later saved not only the motor division but the ophthalmic fibres of the sensory root as well. A still further refinement in the surgical treatment of trigeminal neuralgia was

<sup>1</sup> Read before the New York Surgical Society, December 14, 1927.

## SURGICAL TREATMENT OF TRIGEMINAL NEURALGIA

presented sometime ago by the writer<sup>2</sup> before the New York State Medical Society, Section on Surgery and Neurology, namely, *differential section* of the dorsal root, those fibres within the dorsal root derived from the mandibular division being selected for section when the pain occurs in the domain of the mandibular nerve, and those from the maxillary division for pain in the domain of the maxillary, the remaining fibres being left intact.

Frequently tic douloureux remains limited to the mandibular division for many years before spreading to the maxillary or the ophthalmic division. In differential section fibres derived from the mandibular nerve within the dorsal root are differentiated and cut, leaving the patient with a relatively limited area of anæsthesia and yet free of pain. In cases with pain limited to one division, differential section of the fibres from that division the writer feels is of distinct advantage, a more conservative procedure, and a further desirable refinement of technic, since the destruction of sensory fibres is reduced to a minimum, with complete relief of pain.

In view of these refinements of technic, it does not seem justifiable to treat trigeminal neuralgia in an expectant manner, since, so far as we know no means of permanent relief has been found other than section of the fibres carrying the pain impulses. Once the diagnosis is definitely established, surgical intervention is indicated.

Alcoholization of the nerve trunks, commonly employed in the treatment of trigeminal neuralgia, is an archaic procedure developed at the time when removal of the gasserian ganglion was the only operative means of relief offered. This operation, even in the most skilled hands, had a mortality rate of approximately 14 per cent., and trophic disturbances of the eye were a common sequela. Naturally, under such circumstances any procedure giving relief was preferred to operation. Since then, however, a complete revolution in the operative procedure of trigeminal neuralgia has taken place. The mortality rate has been reduced to less than 1 per cent., local anæsthesia is used as suggested by Alfred S. Taylor, and refinement of technic has made it pos-

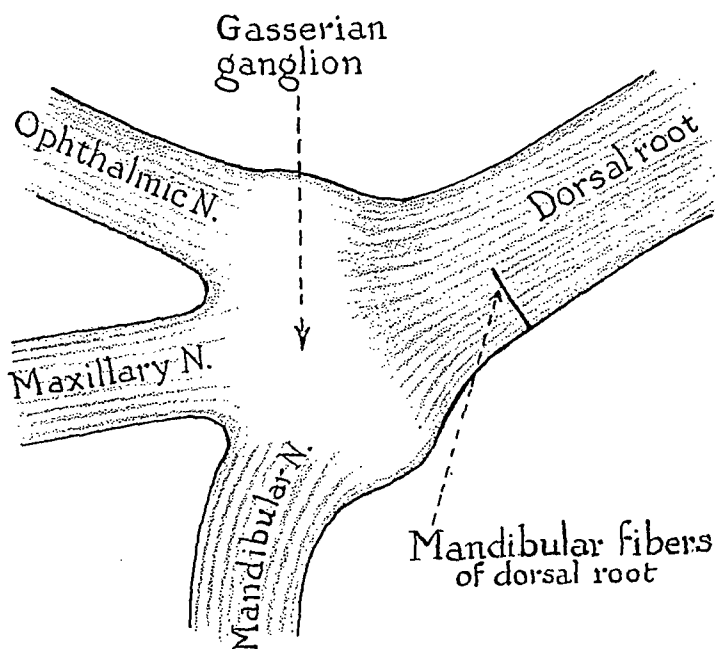


FIG. 2.—Schematic drawing of the gasserian ganglion and dorsal trigeminal root. Line of section to cut the sensory fibres derived from the mandibular division.

<sup>2</sup> Differential Section of the Trigeminal Root in the Surgical Treatment of Trigeminal Neuralgia, New York State Society, New York City, March, 1926.

sible to secure permanent and complete relief of pain with the production of a minimum anæsthetic area. Alcohol injection, on the other hand, is an extremely painful procedure and gives only temporary relief. Operation must eventually be done, frequently after the patient is considerably older and the operative risk greater. The invariable query of patients who, after a series of alcohol injections, have come at length to differential section, is: "Why did I not have an operation in the first place and spare myself the torture of repeated alcohol injections?"

The injection of alcohol into the nerve trunk is furthermore not without danger, since occasionally the arachnoid sheath covering the nerve may descend an unusual length along the nerve trunk and alcohol consequently be injected into the subarachnoid space. For similar reasons injection of

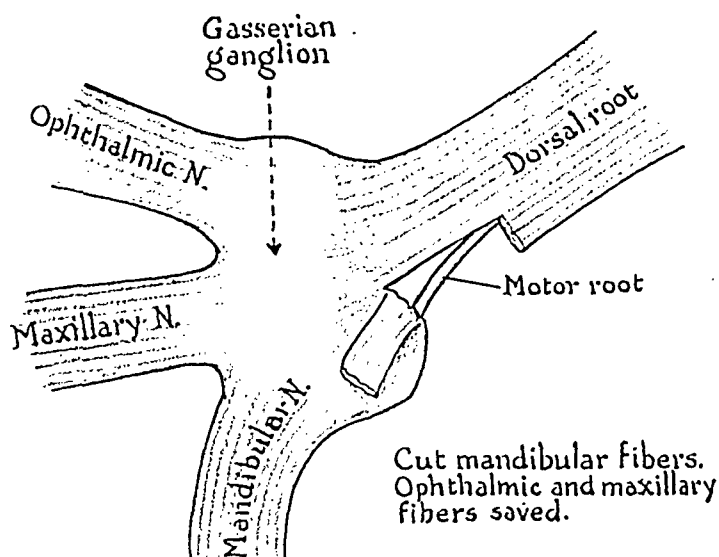


FIG. 3.—Same as 2 with mandibular division cut and reflected showing the motor root passing diagonally beneath the sensory root. The motor root is saved.

alcohol into the gasserian ganglion is dangerous. Since the gasserian ganglion is surrounded by the arachnoid membrane alcohol may be injected into the subarachnoid space and along the dorsal root into the basal cysterne. Alcoholization of the ganglion should, therefore, be condemned. An unfortunate case in which alcohol injection into the gasserian ganglion was followed by

nearly complete paralysis of all of the cranial nerves on both sides has been reported. While it is true that such untoward complications are rare, they are pointed out as evidence that alcohol injection in itself is not altogether as harmless as is generally believed. Alcohol injections should not be used as a routine procedure in the treatment of trigeminal neuralgia, but should be reserved for those special cases in which there is doubt as to the diagnosis, or in which operation of any kind is contra-indicated because of the patient's general condition, or because of some disturbance in vision on the affected side, etc.

Neuralgia in the ophthalmic division is extremely uncommon, occurring in less than 5 per cent. of those afflicted with trigeminal neuralgia. Where there is pain referred over the ophthalmic division, this is frequently found to have originated in the maxillary division, radiating secondarily in the ophthalmic area. To classify such cases as neuralgia of the maxillary and ophthalmic divisions is inaccurate and misleading. They are properly called primary maxillary neuralgia with secondary ophthalmic neuralgia, and are



## SURGICAL TREATMENT OF TRIGEMINAL NEURALGIA

to be distinguished from the rare cases of primary pain in the ophthalmic distribution. If this distinction is made, cases of ophthalmic neuralgia are found to be even rarer than the figures given above would indicate.

That pain in the ophthalmic division is frequently an overflow phenomena rather than true primary pain is, suggested by the fact that injection of alcohol into the second division may relieve not only the pain in the second division, but also that referred along the ophthalmic division; similarly injection of the mandibular division may relieve secondary or referred pain in the maxillary division. While relief of secondary pain may not be experienced if the pain is of long duration, in cases seen early, before the secondary pain impulses have become permanently fixed, complete relief is usually obtained by treating the division primarily involved.

These observations have had an important bearing in pointing the way toward differential section of the dorsal root. In several patients in whom pain occurred primarily in the maxillary division, radiating later into the ophthalmic and mandibular divisions, the ophthalmic has been deliberately spared when section of the dorsal root was done, with relief of all pain. Thus even in some cases of so-called ophthalmic neuralgia, section of the maxillo-mandibular division has given complete relief. The ophthalmic division should be cut only when it is the primary

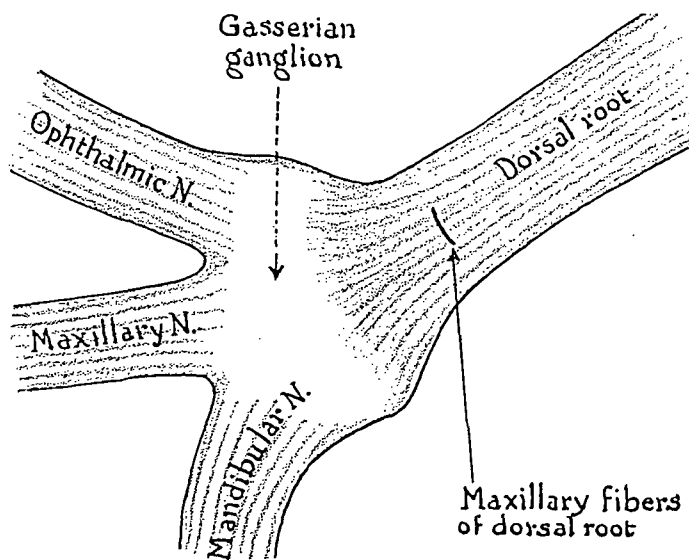


FIG. 4.—Line of section to cut the sensory fibres derived from the maxillary division.

source of the pain. It is thus extremely important to distinguish between the primary and secondary ophthalmic neuralgias, that the ophthalmic division may be saved in all cases except those showing primary involvement of this part of the trigeminal nerve. This is a new conception and is as yet in the experimental stage. It may well be that those in whom this distinction has been made may have recurrence of pain in years to come. Time and further experience alone will tell. One patient, indeed, has had recurrence of pain though in this instance there was some doubt as to whether the ophthalmic pain was primary or secondary. It is my practice to explain the situation to the patient and to the physician by whom he is referred, so that the possibility of recurring pain may be fully appreciated.

Usually a second operation in an old operative field presents special difficulties, but such is not the case with differential section of the trigeminal root. The line of cleavage between the dura and the bone is as readily followed at the second operation as at the first, and bleeding is less, since the

foramen spinosum is already plugged and a dry field is usually assured. Identification of the gasserian ganglion and the dorsal root offers no special difficulty. Since a second operation is as easy or easier than the first, a conservative attitude can be more readily adopted; an obvious advantage.

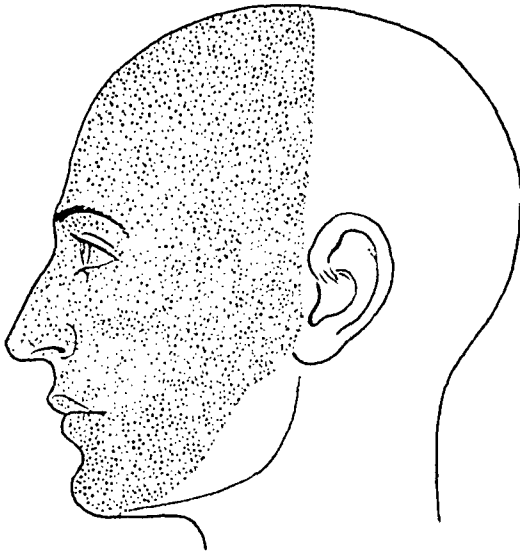


FIG. 5.—Area of anaesthesia after total section of the trigeminal root.

of the ophthalmic nerve fuses with the maxillo-mandibular ganglion and the central connections to the brain stem join those of the maxillo-mandibular to enter the brain stem as a common dorsal root. Further evidence of the separateness of these two nerves is seen within the brain-stem, where the central arms of the ophthalmic and maxillo-mandibular nerves are found as two separate bundles in the descending trigeminal tract, the ophthalmic lying more ventral and the maxillo-mandibular more dorsal.

Human embryological evidence, as pointed out by Giglio Tos (1902)<sup>3</sup> and Frazier and Whitehead (1926)<sup>4</sup> show that the adult gasserian ganglion develops as two separate ganglia, one for the ophthalmic and another for the maxillo-mandibular divisions.

Thus both comparative anatomy and embryology furnish an undeniable basis for the view that the trigeminal nerve is really made up of two nerves, one the ophthalmic and the other the maxillo-mandibular, having had at one

Abundant comparative anatomical and embryological evidence is at hand to indicate the separateness of the ophthalmic nerve from the maxillo-mandibular nerve. The trigeminal nerve is in reality two nerves—the ophthalmic and maxillo-mandibular, which become fused into one. In the lower animals the ophthalmic develops as a separate nerve having its own ganglion and distinct peripheral and central connections. It develops in front of the second myotome while the maxillo-mandibular rises caudal to the second myotome. Later the ganglion

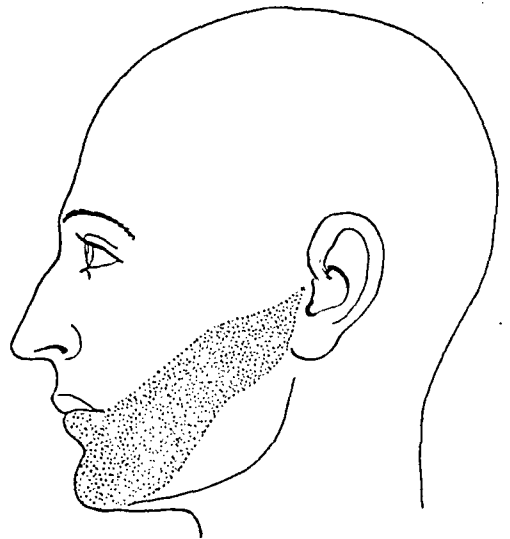


FIG. 6.—Area of anaesthesia after differential section of the trigeminal root for pain limited to the mandibular division (see figure 1).

<sup>3</sup> Tos, Giglio: Sull' origine embrionale del nervo trigemino nell' uomo. *Anat. Anzeiger*, vol. xxi, 1902.

<sup>4</sup> Brain: Vol. xlviii, p. 458, 1926.

## SURGICAL TREATMENT OF TRIGEMINAL NEURALGIA

time in their phylogeny separate ganglia, separate dorsal roots, separate entrances, and a separate course within the brain-stem. With such a foundation, one feels more secure in treating trigeminal neuralgia, not as a unit involving the whole of the adult trigeminal nerve, but as affecting two entities brought together only in their grosser morphology yet retaining their individuality in their clinical manifestations. As often happens, phylogenetic studies point the way to clinical understanding and to more rational and specialized surgery.

In view of such studies and of the clinical observations referred to earlier in this paper, the conservative treatment outlined is felt to be justifiable. As has been mentioned, the profession is greatly indebted to Dr. Charles Frazier for suggesting first that the motor root be saved, and second, that the ophthalmic division be saved in those cases in which the pain is limited to the maxillo-mandibular divisions. This operation Doctor Frazier has designated as "subtotal resection".

A further step in advance, the writer believes, is marked by the suggestion presented some time ago, before the New York State Medical Society, namely that in those patients having so-called ophthalmic neuralgia a distinction be made between primary and secondary ophthalmic pain and that the ophthalmic fibres of the dorsal root be cut only in those in whom the pain in that division is primary. As a still further refinement in the surgical treatment of trigeminal neuralgia, it was suggested that the dorsal root fibres central to the ganglion derived from the mandibular be cut when the mandibular division is the source of pain, or the maxillary when the maxillary is the source of the pain. This procedure which the writer has termed "differential section" has been found valuable by the additional experience since gained. Thus by differential section only those fibres central to the ganglion are destroyed which carry the pain impulses. As yet a sharp line of separation between the maxillary and the mandibular divisions within the dorsal root has not always been possible. An overlap of one or two funiculi is likely to occur at the line of section. With further experience, however, it seems probable that more accurate separation of these funiculi will be possible, and that *differential section of the dorsal root* will find increasing application.



FIG. 7.—Photograph of patient showing area of anaesthesia after differential section of the dorsal trigeminal root. The fibres within the dorsal root derived from the mandibular division were cut for major trigeminal neuralgia with the pain limited to the mandibular division. The sensory fibres from the ophthalmic and maxillary division have been saved as well as the motor root.

CONCLUSIONS

(1) A distinction should be made between primary and secondary or referred neuralgia of the ophthalmic, the maxillary or the mandibular divisions. In early cases of primary neuralgia of the ophthalmic, maxillary or mandibular divisions section of the fibres in the dorsal trigeminal root derived from the division along which the pain impulses are carried, should be done without section of the remaining fibres. In long-standing cases distinction between primary and secondary neuralgia of the various divisions cannot always be made and section of the fibres from two divisions may be necessary, hence early diagnosis and surgical treatment is advisable as soon as the diagnosis is definitely established.

(2) *Differential section* is a further refinement in the surgical treatment of trigeminal neuralgia which has proven a satisfactory procedure in the cases done since the writer's first report was made before the New York State Medical Society in 1926.

(3) By *differential section* is meant section of the fibres within the dorsal root central to the ganglion derived from the division producing the pain without section of the remaining fibres. If the pain is in the mandibular division, the mandibular fibres central to the ganglion are cut without cutting the maxillary or ophthalmic fibres. If the pain is in the maxillary these fibres are cut without injury to the mandibular or ophthalmic fibres. If the pain is in the ophthalmic alone without involvement of the maxillary or mandibular, the ophthalmic fibres are cut.

(4) By *differential section* the fibres are differentiated along which the pain impulses are carried and these only are cut. Thus both the anæsthetic area and the attendant paræsthesias are reduced to a minimum.

# THE RELIEF OF PAIN IN CARCINOMA OF THE FACE\*

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MUCH has been written concerning the treatment of cancer of the face and jaws while but little has been done for the relief of pain in this distressing disease. Persistent pain is a common complaint, particularly in the incurable cases. Many of these patients have ulcerating infected lesions which are extremely sensitive even if they suffer no spontaneous pain, and treatment whether operative or by radiation is frequently painful. Moreover, the period of convalescence is often uncomfortable on account of post-operative infection, painful dressings, radium irritation and the like. Blocking the trigeminal nerve will give relief from all of these discomforts in some cases, and marked alleviation for months in a large proportion of the rest. Thus much needless suffering is saved.

One of us<sup>1</sup> has already reported a number of cases in which this procedure has been tried and these cases are included in the group on which this communication is based.

Section or blocking of the fifth nerve can only be used to stop pain caused by lesions within the distribution of that nerve. In this connection we must remember that these patients frequently have two forms of pain—pain from the original growth and that caused by metastases in the neck. The pain from the metastases is commonly much less severe and there may be no complaint of it at first, on account of the more severe pain from the original lesion. But when the major pain is relieved the less severe may come to the surface and cause some complaint. Under these conditions it may become necessary to sever intradurally the posterior roots from the three upper cervical segments as suggested by Fay,<sup>2</sup> or section the glossopharyngeal within the cranium as described by Adson.<sup>3</sup> Furthermore, it frequently happens that cancer of the pharynx, tonsils or of the deeper nasal sinuses will cause pain which is referred to the face. Unfortunately, this pain cannot be relieved by blocking of the fifth nerve.

The sensory supply of the face and mouth is not as simple as might be supposed from a perusal of the standard anatomies. The trigeminal fibres ramify to the external surface of the face approximately from the level of the line of the lower jaw anterior to the external auditory meatus upward

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\* Read before the American Surgical Association, May, 1927.

to the vertex of the scalp. Within the mouth and nose the mucous membrane lining the cheek, the inferior and superior maxillæ, the hard palate and the lateral and superior surfaces of the anterior two-thirds of the tongue,

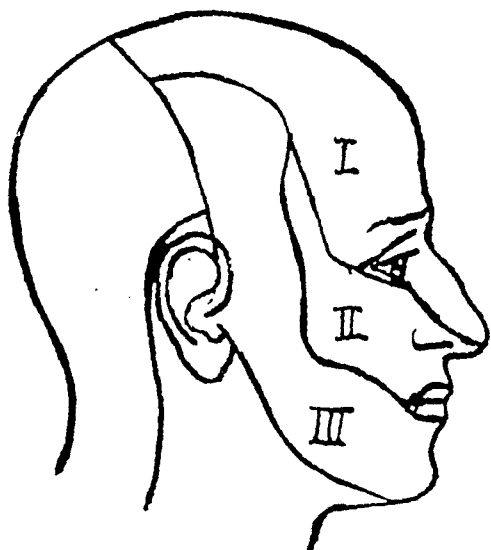


FIG. 1.—Sensory distribution first, second, third divisions of fifth nerve on the skin surface of the face.

together with the anterior half of the nasal septum and turbinates, receive sensory fibres from this source (Fig. 1). But about the periphery of this sensory supply there are definite overlaps from adjacent nerves; the upper cervical nerves below along the line of the mandible in front of the ear and in the floor of the mouth and the glossopharyngeal in the posterior part of the tongue, tonsillar pillars, soft palate, and naso-pharynx. The facial nerve apparently only carries pressure pain sensibility fibres,<sup>4</sup> although even this is denied by other observers.<sup>5</sup> The part played by the sympathetic chains in conveying sensation is less

clearly understood. Nor are we more certain of the sensory supply of the accessory nasal sinuses. The mucosa of the frontal and maxillary sinuses probably receives most of its sensory enervation from the first and second divisions of the fifth respectively, possibly in combination with sympathetic fibres from the sphenopalatine ganglion, but the pathways from the sphenoid and ethmoid cells are less perfectly understood.

It will be evident that a malignant growth involving the posterior and upper nasal sinuses, the tonsillar ring, deeper portions of the floor of the mouth, the pharynx and the ear will not give nearly as satisfactory results following blocking of the fifth nerve as those lesions which are situated in the distribution of that nerve alone. It is essential, therefore, to select the cases carefully with a clear picture of the trigeminal sensory distribution in mind. For although in some of the lesions situated in the areas having a double nerve supply, partial relief may be obtained, but nevertheless the results will not be entirely satisfactory.

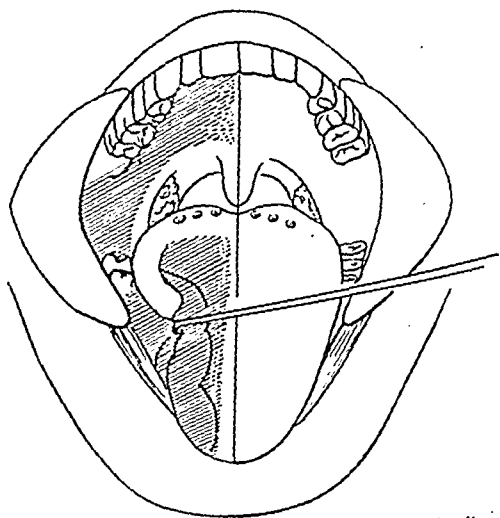


FIG. 2.—The shaded area showed the distribution of post-operative anæsthesia to touch, pain, and temperature over the tongue, hard palate and anterior part of the soft palate on the right in a case of trifacial neuralgia. After J. B. Doyle, *Arch. Neurol. and Psych.*, 1923, vol. ix, p. 34.

Various forms of nerve blocking can be used, including posterior root

# PAIN RELIEF OF CARCINOMA OF THE FACE

TABLE I.

*Table Showing Location of Growth, Type of Treatment and Results. Note That the Least Satisfactory Results Were Obtained Where the Floor of the Mouth Was Involved.*

Location of growth	No. of cases	Treatment	Result
Maxillary antrum and upper jaw.....	23	Alcohol injection, 2nd Div. 9 cases 14 cases	Pain relieved 5. Pain not relieved 4, no anes. obt'd.
Pain relieved.....	13	3rd Div. 2 cases	Pain relieved 2.
Pain partially relieved.	4	2nd and 3rd divisions, 3 cases	Pain relieved 2.
Pain not relieved.....	4		Pain 60% relieved 1.
Died.....	2	Intracran. Neur. 2nd and 3rd Div. 4 cases	Pain 75% relieved 3.
		Avulsion Sens. rt. 5 cases	Died, 1. Pain relieved 4. Died, 1.
Post ethmoid cells and maximum antrum...	2	Avulsion Sens. rt. 2 cases	Pain 60% relieved 1. Pain relieved 1.
Pain relieved.....	1		
Pain partially relieved.	1		
Cheek—skin.....	7	Alcohol injection, 2nd Div., 2 cases 3 cases 2nd and 3rd Div. 1	Pain relieved 1. Pain not relieved 1.
Pain relieved.....	6		Pain relieved 1.
Pain not relieved.....	1	Intracran. Neur., 2nd and 3rd Div. 2 cases	Pain relieved 2.
		Avulsion sens. rt. 2 cases	Pain relieved 2.
Cheek—Mucous membrane.....	1	Alcohol injection, 2nd Div. 1 case	Pain 60% relieved 1.
Partially relieved.....	1		
Tongue.....	7	Alcohol injection, 3rd Div. Inf. dental and lingual 7 cases nerves	Pain relieved 5.
Pain relieved.....	6		Pain partially relieved 1.
Pain partially relieved.	1	1st and 3rd Div.	Pain relieved 1.
Inferior maxilla.....	10	Alcohol injection, 3rd Div. 7 10 cases	Pain relieved 6. Pain 75% relieved 1.
Pain relieved.....	7	Inf. dental and lingual nerves 2	Pain 60% relieved 2.
Pain partially relieved.	3	2nd and 3rd Divs. 1	Pain relieved 1.
Tongue and floor of mouth.....	12	Alcohol injection, 3rd Div. 9 cases	Pain 50% relieved 2. Pain relieved 1.
Pain relieved.....	1		Pain not rel'd 6.
Pain partially relieved.	7	Avulsion sens. rt. 3 cases	Pain 75% relieved 1.
Pain not relieved.....	3		Pain not rel'd 1.
Died.....	1		Died 1.

section, intracranial neurectomy of the second and third divisions and alcohol injection of these branches peripherally. We have not used peripheral neurectomy or injection of the Gasserian ganglion with alcohol. While these procedures may have a place in the control of pain from new growths, we have felt that the methods we have used would be more satisfactory.

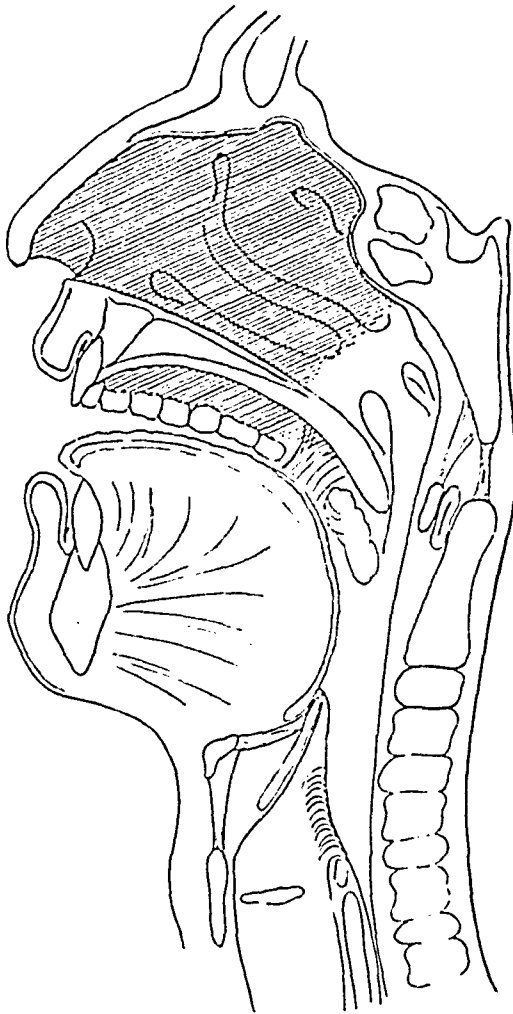


FIG. 3.—The shaded area shows the distribution of post-operative anesthesia to touch, pain, and temperature over the lateral wall of the nasal cavity, hard palate, and anterior part of the soft palate on the right in a case of trifacial neuralgia. After J. B. Doyle, *Arch. Neurol. and Psych.*, 1923, vol. ix, p. 34.

We feel that the method of choice in handling a case of carcinoma of the upper or lower jaw, buccal mucous membrane or antrum where pain is or probably will be a factor, is intracranial section of the second and third divisions and plugging the foramina through which they pass with bone wax as a preliminary to treatment of the new growth. By preserving the first division all possibility of trophic eye complications is avoided. This method is applicable to cases in which the lesion is in the distribution of the second and third divisions and in which treatment by surgery or radium may be expected to prolong life. This operation is not a difficult one—not as difficult in fact as cutting these divisions outside the skull. Where there is any contra-indication to the use of a general anæsthetic it may be performed with infiltration by novocaine. In several instances we have tied the external carotid as a first step. This makes the neurectomy easier and is of considerable advantage to the surgeon who is to handle the treatment of the

new growth, particularly if he wishes to perform an excision. In some instances the neurectomy has been immediately followed by excision with the cautery knife and in others the excision has been postponed. No anæsthesia is needed for the excision except a little novocaine toward the median line, or back on the soft palate. The patient is conscious throughout the operation, can keep his pharynx and trachea clear of blood and mucus, and post-operative dressings are painless. If radium is used there is no pain from radium irritation as so often occurs. If the growth involves the floor or the contents of the orbit, upper part of the nose or the forehead, a posterior root section, rather than intracranial neurectomy should be performed,



## PAIN RELIEF OF CARCINOMA OF THE FACE

as section of the first division any great distance back of the supra-orbital notch is impracticable.

We may occasionally see one of these cases where the growth is so situated that an alcohol injection is sufficient to permit the necessary surgical procedures to be performed and give a painless convalescence. In our experience, however, this has been the exception and not the rule. Naturally, if this minor procedure is all that is necessary, the more formidable operation should not be considered.

In case of doubt as to the possibility of relief of pain by intracranial section on account of the situation of the new growth, or on account of metastasis outside the distribution of the trigeminal nerve, a preliminary injection with alcohol or novocaine of the second and third divisions may be given. If pain is relieved to a sufficient extent to make intracranial section worth while, the operation can be performed at once or, if desired, when the pain recurs. It should be remembered in this connection that the situation of the new growth may be the determining factor in favor of intracranial section. If a radical removal is to be performed later, it is unwise to go through diseased tissue to block the nerve with alcohol. Moreover, there may be sufficient distortion of the position of the nerve due to the growth to make it difficult to inject it accurately with alcohol.

The greater number of these patients have been sent to us for the relief of intractable pain, late in the course of the disease, after surgical measures and application of radium for the control of the process have already been tried. Some of them have had extensive ulcerative growths, some painful septic wounds, while others have been suffering from the distress which follows the application of radium in some form or other. In this group further treatment of the growth can at best be only palliative. The presence of extensive metastases or direct extension of the new growth outside the distribution of the trigeminal nerve complicates the picture and should not be overlooked. For this reason we feel that in these advanced cases alcoholic injection of the appropriate trigeminal division should be first attempted. If the resulting anæsthesia indicates a successful injection, and if the pain is not relieved, further procedures directed against the fifth nerve are useless. Cervical rhizotomy or section of the glosso-pharyngeal may be necessary,



FIG. 4.—Case of carcinoma of jaw and cheek. Intracranial neurectomy—second and third divisions of fifth nerve. Note area of anæsthesia.

measures which are not included in the scope of this article. The relief of pain in these late cases is often most striking, but by this time these sufferers are in poor condition and frequently drug addicts. Even if their pain is completely relieved they are still incapacitated and unable to take up any occupation.

In two instances where pain persisted after blocking the fifth nerve, injection of the sphenopalatine ganglion has been performed for us by

TABLE II.  
*Brief Resumé of Results.*

	Relief	Partial relief	Failure	Dead
Intracranial operations, 18.....	12	5	1	3
Deep injections, 44.....	25	8	11	0
Superficial injections, 3.....	0	3	0	0

Removal of growth without anæsthetic after treatment ..... 7 cases

Dr. V. H. Kazanjian, with definite, though only partial, relief. This injection should be considered in all cases of new growth involving the region of the posterior nares or upper nasal sinuses where blocking the trigeminal nerve is only partially successful in relieving pain.

#### CONCLUSIONS

We feel that any patient suffering severe pain from a neoplasm, wholly or in large part, within the distribution of the trigeminal nerve, may be greatly relieved by blocking or sectioning this nerve or some of its branches.

That not only can pain from the new growth be relieved, but the suffering caused by the various forms of treatment used for this disease can be ameliorated.

That the patient's general condition can be improved in many instances on account of increased ability to take nourishment.

That the method of choice in suitable cases is intracranial section and that this procedure should be carried out prior to treatment of the new growth if pain is or probably will be severe.

That alcoholic injection has a definite place in the control of pain, particularly in advanced cases.

We wish to express our thanks to the members of the Department of Röntgenology of the Hospital of the University of Pennsylvania, of the Department of Röntgenology and Tumor Clinic of the Massachusetts General Hospital and to the Staff of the Huntington Memorial Hospital for their interest and help in this work. These cases have all been seen through the kindness of these gentlemen and they have been of great help to us in formu-

## PAIN RELIEF OF CARCINOMA OF THE FACE

lating our ideas. In several instances they have postponed direct attack upon the new growth until after we have endeavored to render the area involved painless.

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# BRANCHIAL ANOMALIES AND NEOPLASMS

A REPORT OF THIRTY-TWO CASES WITH FOLLOW-UP RESULTS

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THE branchial anomalies are the so-called branchial cysts and fistulas, cervical and auricular appendages, fistula auris congenita and a neoplasm supposed to arise from vestigial remnants, branchial epithelioma. As the late results of operative treatment have been reported only in relatively few instances, we have included this information in regard to our own cases presented in some detail in the appended synopses.

Before and after Hunczowski's<sup>1</sup> report in 1789 of what was subsequently believed to be branchial fistula, a host of writers described various swellings and fistulas in the neck under as many names. These periods yielded very little accurate scientific data, although some of the symptoms and signs of branchial anomalies were given clearly. The initial descriptions of these conditions were followed by other contributions in French, German, Latin and English, including those by Dzondi,<sup>2</sup> Asherson,<sup>3</sup> Heusinger,<sup>4</sup> Fisher,<sup>5</sup> Cusset,<sup>6</sup> von Volkman,<sup>7</sup> Senn,<sup>8</sup> Quénu,<sup>9</sup> Richard,<sup>10</sup> Hahne,<sup>11</sup> Gussenbauer,<sup>12</sup> Sultan,<sup>13</sup> Perez,<sup>14</sup> Veau,<sup>15</sup> Whitacre,<sup>16</sup> and Siegel.<sup>17</sup> After 1880, the clinical manifestations of branchial anomalies were familiar to many, but the literature was full of varied discussion on their embryology and pathology. The origin of these lesions in some vestigial remnant of the branchial apparatus or the thymo-pharyngeal duct leads us to a consideration of the various suggestions that have been made.

*Embryological Hypotheses.* 1. *The Branchial Cleft Hypothesis.*—Rathke,<sup>18</sup> in 1828, first described the branchial clefts in animals and humans. Sutton,<sup>19</sup> Fig. 1, and Cusset,<sup>6</sup> Fig. 2, concluded that there were in embryos of lower animals five branchial arches separated by five clefts and that if any of the lower clefts were not obliterated by the growth of the corresponding arch an abnormality such as branchial fistula would result. These observers assumed that the condition in the human embryo is analogous and that branchial fistulas can occur at levels corresponding to the various unobliterated clefts. Whether or not this assumption is correct, clinical observation has shown that the internal opening in complete fistula always occurs in the supratonsillar fossa (von Kostanecki and von Mielecki<sup>20</sup>), which corresponds with the second cleft, as will be explained later. The next hypothesis was evolved in order to explain this phenomenon.

2. *Rabl's Hypothesis.*—Rabl<sup>21</sup> pointed out that in the early embryo there

## BRANCHIAL ANOMALIES AND NEOPLASMS

are four branchial bars numbered consecutively from above down. Each is a protrusion with an ectodermal furrow above and below. These furrows do not normally communicate with the entodermal furrow which springs from the pharynx. The subsequent development of the mesoderm in the pouches and its circular segmentation produce the branchial arches. The two sides of the first, or mandibular arch, meet to form the mandible. The second, or hyoid arch (Fig. 3), grows rapidly downward and in front, invading the entire future cervical region. A recess, known as the pre-cervical sinus (Fig. 3), which develops from the overgrowth of the second branchial arch accompanied by the atrophy and posterior displacement of the two arches below, is practically obliterated. The potential space which occurs from the apposition of ectoderm against ectoderm is obliterated by a disintegration of its cells. The furrow beneath the second branchial arch, which is very deep at its posterior end, persists longer than the other transitory conditions. The future site of the tonsil is at the internal invagination of the entoderm and is on the same level as the second furrow. Normally, in a mammal, there is no such final communication at this point between ectoderm and entoderm as exists in fish, where such communications produce the gill cleft. The third and fourth furrows gradually become stretched out and flattened, the third becoming the thymus. The fourth is separated from the entoderm by a very thick layer of mesoderm and a break into the precervical sinus at this point is scarcely probable. It is accordingly evident that the level of the second furrow is the logical point at which a fistula may enter into the pharynx.

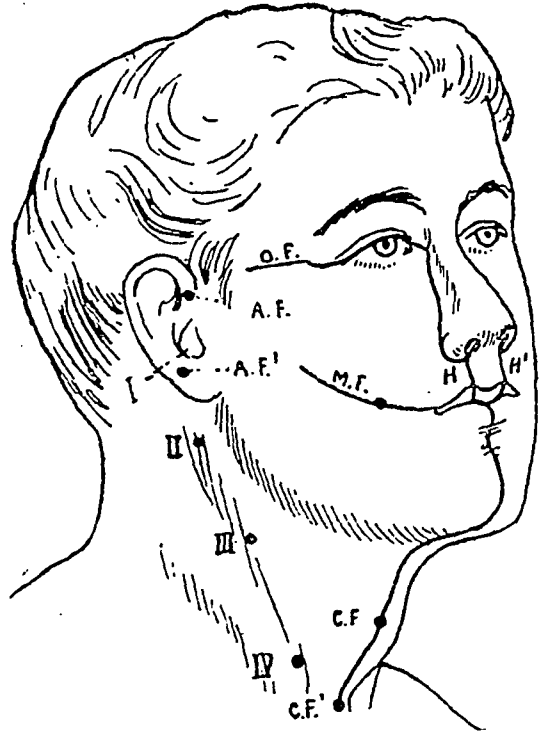


FIG. 1.—Sites of branchial cleft anomalies according to Sutton<sup>19</sup>.

All the following types of branchial abnormalities become readily understandable:

*a.* The external opening may be high or low in the neck, depending on the downward extent of the growth of the second branchial arch (hyoid arch). In no case would it be above the structures derived from the hyoid arch or below the sternoclavicular junction. The invagination or evagination of the arch determines the external opening with respect to the midline.

*b.* The blind end of an incomplete external fistula is a continuation of the vestigial remains of the ectoderm of the precervical sinus.

*c.* If the second arch obliterates the precervical sinus, but the second

furrow persists and communicates with the pharyngeal entoderm, an incomplete internal fistula results.

d. A cessation of complete downward growth of the second arch, accompanied by a break through the mesoderm at the level of the second furrow, will produce a complete branchial fistula.

e. If both internal and external openings are lacking and the precervical sinus has not been completely obliterated, a branchial cyst will result.

Figure 3 illustrates how an irregular development of the second arch results in a continuance of the precervical sinus which is normally obliterated.

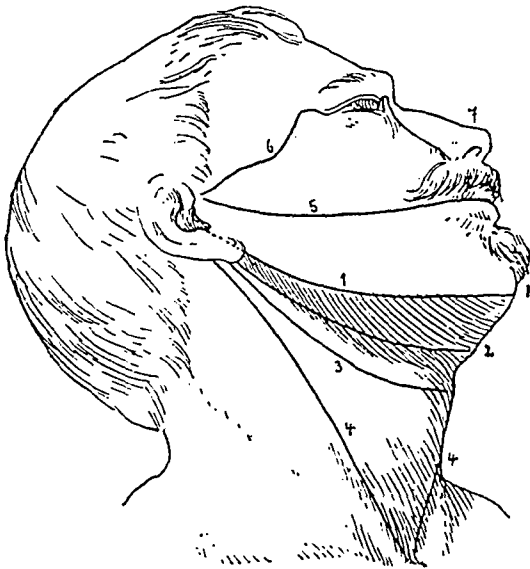


FIG. 2.—Sites of branchial cleft anomalies according to Cusset<sup>6</sup>. He thought that there were seven clefts and that the fourth gave rise to most of the anomalies.

This produces various abnormalities, ranging from fistulas and cysts to monstrosities.

### 3. Wenglowski's Hypothesis.—

Wenglowski<sup>22</sup> contends that branchial anomalies can occur only above the hyoid bone and that the thymo-pharyngeal duct is the anlage for cysts and fistulas below the hyoid. In embryos of about 6 mm. the thymus appears as an entodermal evagination from the ventral part of the third branchial groove on both sides. This evagination communicates with the pharynx by a tract in its centre, the thymo-pharyngeal duct, which later becomes obliterated and,

in embryos of 14 mm., loses its connection with the parent epithelium. From the pharyngeal pouch the thymo-pharyngeal duct passes caudally, laterad and dorsally; it then makes an angle to course caudally, mesially and anteriorly over the superior portion of the thyroid gland, subsequently, about the sixth week of fetal life, to reach the supracardiac area in the substance of the thymus (Fig. 4). At the same time the duct becomes obliterated in its upper part and the remainder is an epithelial-lined tract which, near the pharynx, is characterized by ciliated columnar epithelium. Lymphoid-like cells are found beneath the epithelium. By these observations Wenglowski explains how cysts and fistulas may arise from the thymo-pharyngeal duct.

It would seem that there are several points which this theory does not explain. Branchial structures may occur altogether above the hyoid bone and above the jaw, and it would be difficult to explain the constant occurrence of lymphoid tissue, presumed by Wenglowski to come from the thymus, in the walls of fistulas and cysts in these locations. It would also be difficult to explain the inconstant position of the external openings of fistulas and the relatively high locations of most branchial cysts.

## BRANCHIAL ANOMALIES AND NEOPLASMS

4. *Frazer's Hypothesis*.—Frazer<sup>23</sup> presents the possibility that branchial rests may not come from the precervical sinus but rather from the "placodal cysts" or ducts, or from the ectodermal "external pharyngeal ducts" which are connected with the entodermal pouches.

There might also be abnormal fusion between the sides of the second groove in some part of its extent. Frazer has also shown how embryologically the hypoglossal nerve might come into relation with branchial cysts.

### *Branchial Cysts*.—

There were twenty of these in this group. They have been referred to under a variety of names, among them "sequestration dermoids".<sup>24</sup> Although it has been taken for granted generally that they occur only in the branchial areas, Coakley<sup>25</sup> reported a case in which the tumor apparently sprang from the nasopharynx and Fredet and Chevassu<sup>26</sup> spoke of an intraparotid branchial cyst. Whether or not the condition in Coakley's

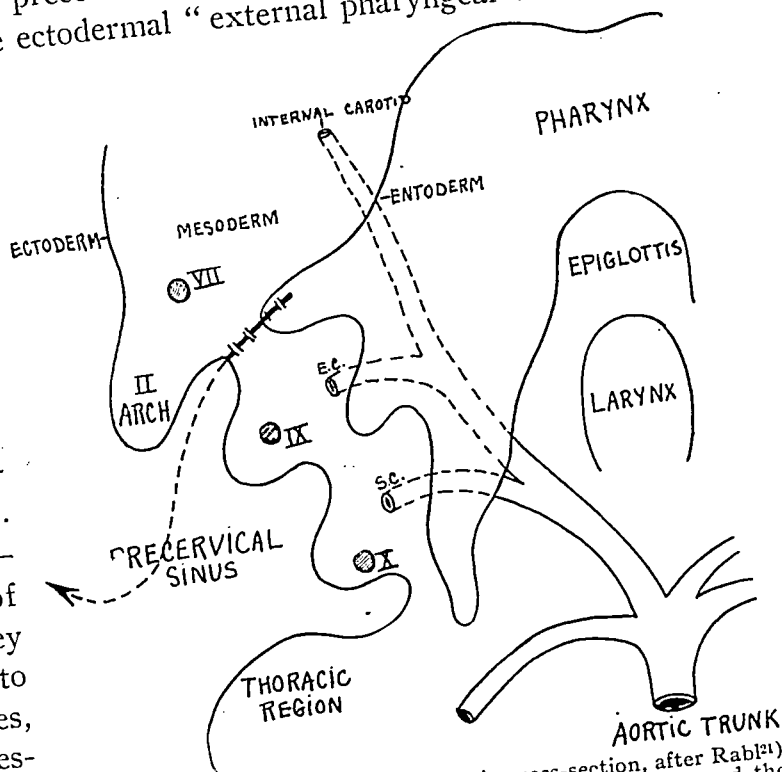


FIG. 3.—Embryo of mole (schematic cross-section, after Rabl<sup>21</sup>) showing the predominant second arch, the precervical sinus and the path of a complete branchial fistula (---) with the break through the mesoderm into the pharynx (---). (Drawn by Dr. J. Alonzo.)

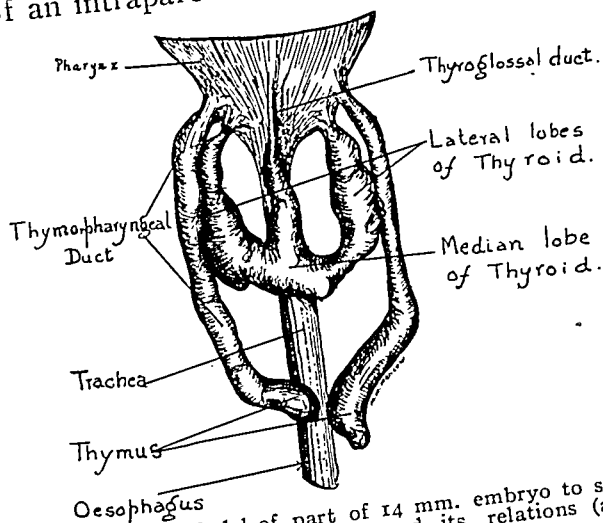


FIG. 4.—Model of part of 14 mm. embryo to show the thymo-pharyngeal duct and its relations (after Wenglowski<sup>22</sup>).

patient might have been a cystic tumor of the hypophyseopharyngeal duct is open to question. A familial tendency has been recorded only by Carwardine<sup>27</sup> who reported a branchial "dermoid" in a woman whose mother had "a small cervical tubercle." This patient had accessory abnormalities: a branchial cervical tubercle and an additional antitragus on the same side.

In this series they all had a stratified squamous epithelial lining with well-developed germinal centres averaging 1 mm. in thickness in the fibrous tissue outside of the epithelial lining (Fig. 7). This serves to distinguish them from thyroglossal

cysts and fistulas which practically never have lymphoid tissue in the wall. McFarland<sup>28</sup> says that there may be stratified columnar ciliated epithelium lining parts of some cysts. Virchow<sup>29</sup> observed a cartilaginous plaque in the



FIG. 5.—Photograph of patient with branchial cyst (case history No. 21507). Note the high position of the swelling in the sterno-mastoid region.

wall of one cyst. Where infection had occurred, part of the epithelial lining was replaced by granulation tissue. The cyst wall was usually about 1 mm. thick (Fig. 6), but if there had been long-standing inflammation it might be as much as a centimetre in thickness due to fibrosis; with inflammation it was customary to find one or more enlarged lymph-nodes in close approximation to the cyst wall.

From an analysis of these cases it appears that they occurred most frequently in the third

decade, although infancy and old age were not exempt. Females were preponderant in a proportion of two to one. In the majority of cases the anomaly was found on the left side. Occupation seemed to have no importance as an etiological

factor. As a rule, the swellings of the cysts gradually increased in size, but some diminished and increased alternately. Occasionally their size was stationary for a long time and then suddenly became larger. The average duration of the swelling before relief was sought was about one year. Most of the



FIG. 6.—Photograph of excised cyst after it had been opened, hardened and the contents evacuated. (Case history No. 43364).

cysts were located beneath and anterior to the sternomastoid just below the mandible. Some were small, others large, the average diameter being about 5 cm. The majority were encapsulated and fluctuant or cystic. About half



## BRANCHIAL ANOMALIES AND NEOPLASMS

were movable and the others were loosely attached to the deeper structures. Skin reaction was the exception. A cold or sore throat frequently preceded their appearance or increase in size. Pain was unusual and when present occurred locally in a mild degree or only on swallowing. Infection of the cyst had some effect in the production of this last symptom. Several cysts, which had been erroneously incised before admission to the hospital, continued to drain. At operation, the anatomical location of the cysts was studied with especial reference to their relations with the great vessels (Fig. 8). Eighty-five per cent. extended down to them and the remainder were either superficial or passed from the surface deep to them. In this series one prolongation of the cyst wall ran to the "base of the skull" and another



FIG. 7.—Microphotograph of cross-section of cyst wall showing stratified squamous epithelial lining and external to it the lymphoid tissue and the fibrous tissue wall (case history No. 56966).

to the parotid region. Bailey<sup>30</sup> described a fourth variety which is between the vessels and the pharyngeal wall. The contents of the cysts was thick amber to turbid or purulent fluid or pale necrotic material resembling caseation necrosis. This fluid may contain epithelial cells or their degeneration products, cholesterol crystals. The close resemblance of cysts to cold abscesses originating in cervical lymph-glands resulted in this incorrect diagnosis in half of our cases. The same error was made in the six cases reported by Bailey<sup>30</sup> and in cases reported by Johnson<sup>31</sup> and by McKenty.<sup>32</sup> In this connection, it is interesting to note that about half of our cases had swelling of surrounding lymph-glands. Complications that may occur are fistula formation, a superimposed epithelioma, or infection of the cyst with subsequent spontaneous or traumatic rupture of the overlying skin.

The chief clinical diagnostic problem is the differentiation of these cysts from tuberculous adenitis with or without abscess formation. A single cystic painless movable and non-tender swelling, gradually increasing in size and found in the upper half or third of the sternomastoid region is very apt to be a branchial cyst. A solitary broken-down tuberculous abscess, not associated with other much enlarged tuberculous glands, simulates this closely. In tuberculosis the overlying skin is more often a dull red, there is closer

attachment to surrounding structures and if a röntgenogram shows calcification the diagnosis is practically assured. If cholesterol crystals are found in the aspirated contents, an epithelial-lined cyst may be suspected. Other conditions for differential diagnosis, mentioned by Bailey,<sup>30</sup> are cavernous hemangioma and lymphangioma, aneurism, lipoma, thyroglossal cyst, chronic retropharyngeal abscess and a degenerated malignant neoplasm.

Treatment consisted in complete excision of the cyst wall and in the late results in fourteen of our cases there were no recurrences.

*Branchial Fistulas.*—There were four of these studied in this group. The fistulas like the cysts were all lined with stratified squamous epithelium and had lymphoid tissue in the wall (Fig. 9). In addition there was often stratified columnar epithelium lining the deeper parts of the tracts and both types of epithelium were sometimes found in the same section. We did not observe any cilia servers have reported that they might have been destroyed during the removal of the tissue we studied. In one case there were numerous accessory tracts or diverticulum lined with similar epithelium adjacent to the main tract. Serous glands, resembling the capsule of the tonsil, were found close to the tract of the pharyngeal complete

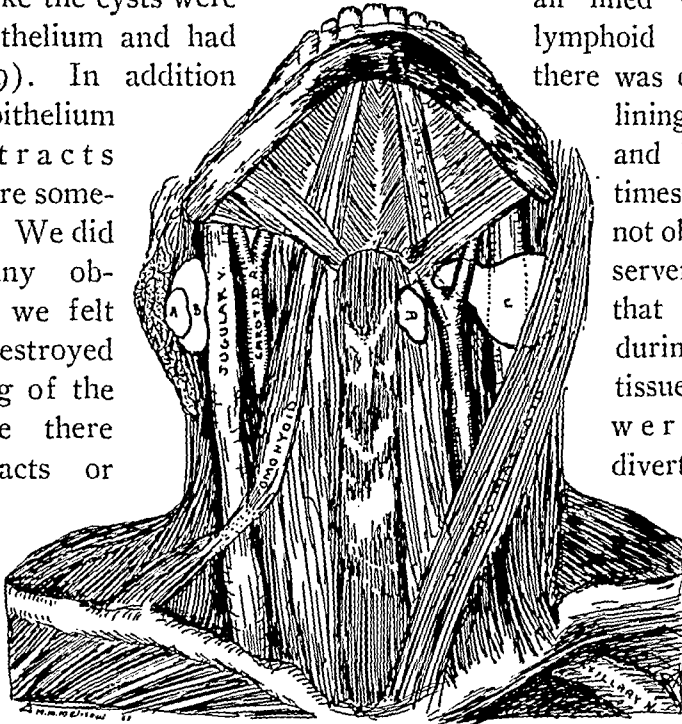


FIG. 8.—Schematic drawing to show the various possible positions of branchial cysts with respect to the great vessels. A. The superficial type. B. The type which is preponderant. The cyst extends down to the great vessels. C. The type which extends from the superficial tissues down between the external and internal carotid arteries. D. The type described by Bailey<sup>30</sup> which is deep to the great vessels and near the pharyngeal wall.

Heusinger<sup>33</sup> observed cartilage in the wall of a fistula. They were all congenital, but a very small external opening which did not discharge caused some of them to be overlooked. It is generally believed that they are more frequent in females and that they are found in the majority of cases on the left side. A familial tendency was first reported by Asherson,<sup>3</sup> and Tilley<sup>34</sup> mentioned four members in a family of eight who had branchial fistulas. Fischer<sup>35</sup> found hereditary influence in 21 out of 100 collected cases. One of our cases had a bilateral branchial fistula and her father, paternal grandfather, brother and female cousin on her father's side all have bilateral cervical fistulas. Another brother had a proven branchial appendage.

Fistulas have been divided into: 1. External complete—those with only an outer opening. 2. Internal incomplete—those with only an inner opening. 3. Complete—those with an internal and external opening.

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The external openings have been usually pinhead in size and located, as a rule, along the anterior border of the sternomastoid below the level of the thyroid cartilage. They have varied in size and position, occurring even above the mandible as reported by Virchow.<sup>36</sup> When occurring in the mid-line, the diagnosis of thyroglossal fistula must be eliminated. In all of our cases the external openings eventually developed swellings around them. Discharge from the opening was sometimes delayed several years and sometimes initiated by some respiratory infection. It varied in character from thin and watery to mucoid or purulent. The presence of hair in the tract has been reported.<sup>37</sup>

In one of our cases a chronic unproductive cough was stopped promptly by excision of the incomplete external fistulous tract. At operation it was found adherent to the vagus. The clinical relation of branchial fistula to irritation of the vagus and glossopharyngeal

nerves has been discussed in a previous communication by one of us.<sup>38</sup>

The tract was usually felt partly in the subcutaneous tissues and on dissection it was found to pass backward in the direction of the pharynx, coming into relation with the carotid sheath or the internal and external carotid arteries, or possibly the ninth, tenth or twelfth cranial nerves, or the digastric muscle. Its pharyngeal end was usually thin and friable. The inner opening of a complete fistula has always been reported in the supratonsillar fossa and it was there in our cases. In one of these it was first noticed after a tonsillectomy. Kramer<sup>37</sup> also has reported this. A foul and profuse discharge into the pharynx speaks strongly for the presence of an inner opening. This opening has been demonstrated by successful probing of the tract, the injection of a colored or bitter solution through the

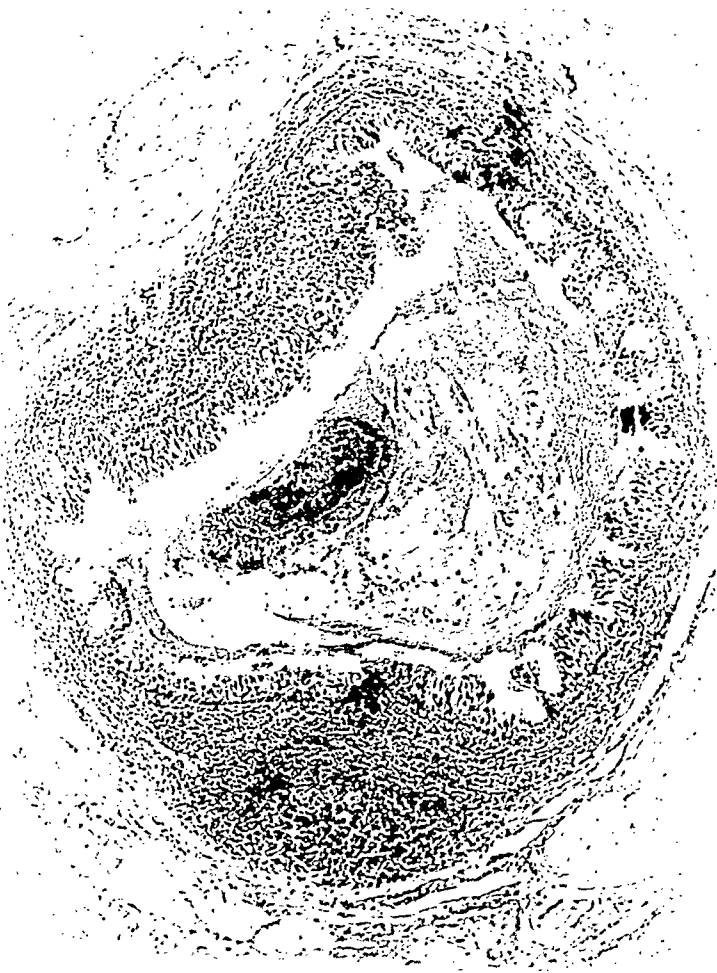


FIG. 9.—Microphotograph of branchial fistula near its pharyngeal end showing stratified columnar epithelium lining it, a lymph follicle in the wall and surrounding it striated muscle. In the lumen is blood and epithelial debris. (Case history No. 69188).

external opening which appears in the pharynx, or by actual visualization of the opening in the pharynx. The tract has been shown in the röntgenogram when injected with an opaque substance.

The treatment of all fistulas has been surgical and success has depended upon a complete excision of the tract. Von Hacker<sup>39</sup> described the best method of dealing with the inner end of complete fistulas after dissection had been made as far back as possible, by inversion into the pharynx. This

has also been carried out by Gross,<sup>40</sup> Meyer,<sup>41</sup> Lilienthal<sup>42</sup> and Douglas.<sup>43</sup>

That complete removal of the tract will prevent a recurrence has been demonstrated by the late results of all the cases of this series.

*Cervical and Auricular Appendages and Fistula Auris Congenita.*—The appendages, of which there were four in this series, are congenital and usually occur in front of the tragus or concha of the ear, or in the anterior cervical region (Fig. 10). The branchial appendages are soft nipple-shaped protuberances covered by hair-bearing skin. They are held erect by a

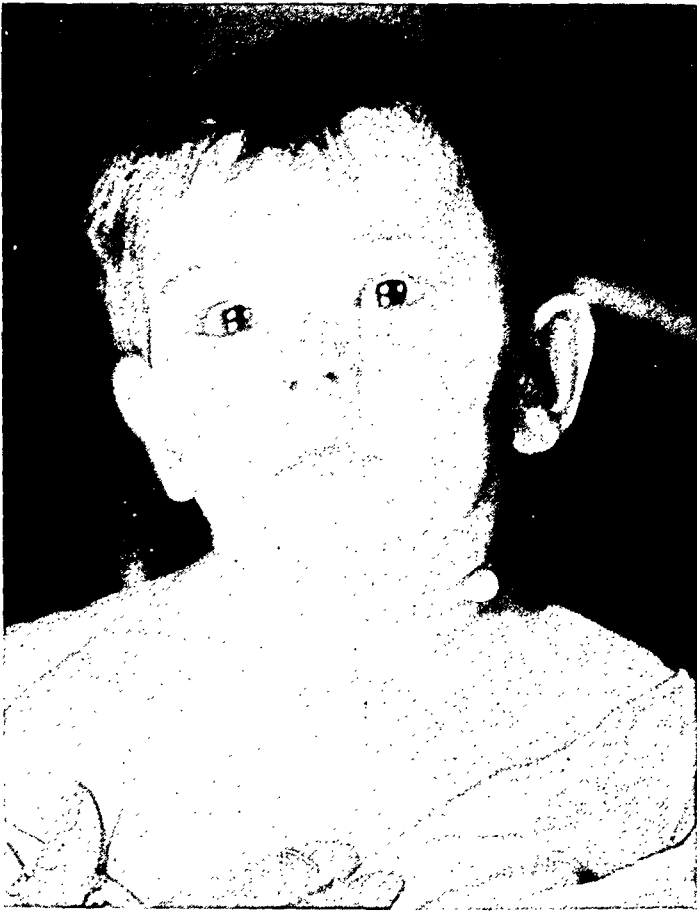


FIG. 10.—Photograph of cervical appendage.  
(Case history No. 37556).

central bar composed of any of the three types of cartilage (Fig. 11), giving a sensation of firmness on deep palpation. They may increase in size and at operation the cartilage was found superficial to the fascia. Their complete removal prevents any recurrence. Siemens<sup>44</sup> and also Guszman<sup>45</sup> have described them at length. The latter found that preauricular appendages occur mostly on one side. In an examination of 11,000 people they were found bilaterally only once. In the neck they occur less frequently, have been found in several members of one family and in association with other abnormalities (Ferran.<sup>46</sup>) Klausner<sup>47</sup> have described them in animals. Clarke<sup>48</sup> has seen cervical appendages proved microscopically in the goat and pig. There was a familial tendency in these animals.

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Fistula auris congenita is frequently seen and has been described by Hahne,<sup>11</sup> Hamann,<sup>49</sup> and Stammers.<sup>50</sup> The last reports six cases of pre-auricular fistulas originating in two different families. His opinion is that they do not originate in the branchial apparatus but in an aberrant coalescence of the six tubercles destined to form the pinna. It is generally conceded, however, that they are branchial in origin. At times they discharge a turbid or purulent fluid. An excision of the fistula will show it to end blindly in the subcutaneous tissue or parotid fascia.

*Branchial Epithelioma.*—Von Volkman,<sup>51</sup> in 1882, was the first to describe



FIG. 11.—Microphotograph of oblique section through appendage shown in figure 10 showing the cartilaginous plaque in the centre. Many hair follicles are shown in the skin.

this condition in man. Other contributors have been Leboeuf,<sup>52</sup> Zicas,<sup>53</sup> Brûnet,<sup>54</sup> Veau,<sup>15</sup> Siegel,<sup>17</sup> Perez<sup>14</sup> and Lorenz.<sup>55</sup> They have also been described in the dog<sup>56</sup> and the horse.<sup>57</sup>

Malignant epithelial neoplasms apparently arising from branchial epithelium are relatively rare in our experience at the Presbyterian Hospital. During a ten-year period, from January 1, 1915, through December 31, 1924, approximately 3961 neoplasms of all kinds were observed; 1538 of these were cancers and only four of these were thought to have had a branchial origin. It is possible that some of the branchial epithelial neoplasms that have been reported as such may have had some tiny overlooked primary

focus in the mouth, pharynx, larynx, sinuses, œsophagus or some distant site. McKenty,<sup>32</sup> Richardson,<sup>58</sup> Brandt,<sup>59</sup> and Hudson<sup>60</sup> stress the significance of this point. Even an autopsy may not be conclusive.

As Ewing<sup>61</sup> reiterates, these are ramifying cystic growths with squamous epithelial cells forming the lining of the cysts and infiltrating the surrounding tissues. In addition we found with Johnson and Lawrence<sup>62</sup> that the epithelial lining of these cysts often formed papillary projections into the

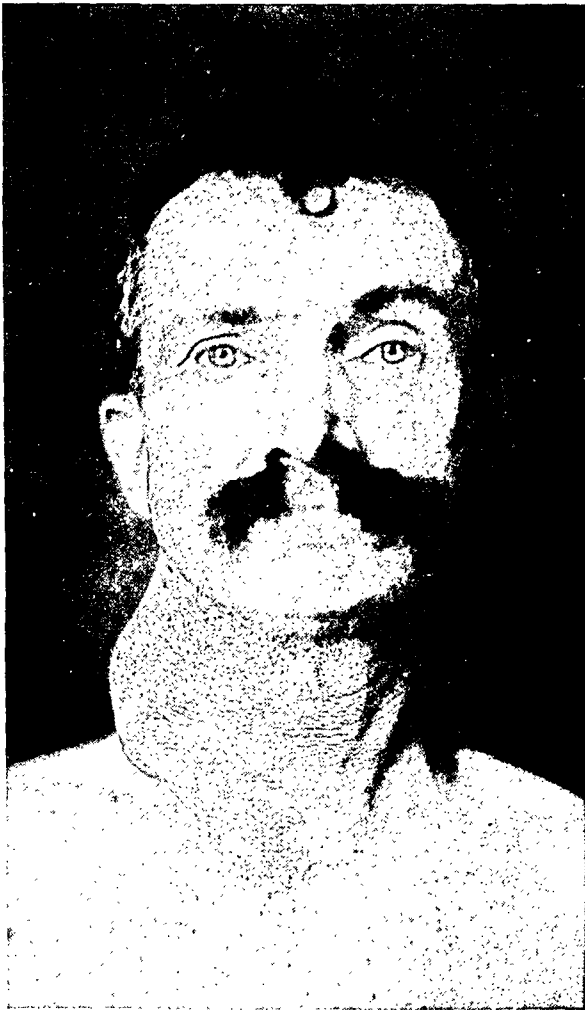


FIG. 12.—Photograph of tumor produced by branchial epithelioma. It was adherent to all surrounding structures, the surface was coarsely nodular, hard and fluctuant in the lower portion. (Case history No. 35740).

lumens (Fig. 13). All four of the neoplasms which we are reporting conformed to this type. In no reported case, nor in these present cases is there scientific proof of an origin from branchial epithelium. The absence of a discoverable primary focus and the distinctive gross and histological features are strong presumptive evidence of a probable common origin in branchial cleft epithelium.

All our cases were in males above the age of forty. In cases which Veau<sup>15</sup> collected from the literature, he found forty-seven males to one female, and Siegel<sup>17</sup> agrees in the great preponderance of the condition in the male sex. Hudson<sup>60</sup> has emphasized that most of these patients are employed in a dust-laden atmosphere and three of our cases come in this group. The swelling comes on gradually or very rapidly and occasionally a patient states that it diminishes in size. It is usually situated

about the middle third of the sternomastoid region, is irregularly nodular, hard, usually cystic and fluctuant in parts, and adherent to all the surrounding structures (Fig. 12). Red or violaceous skin color, tenderness, breaking down in localized areas or sinus formation may occur. Pain may be either localized or radiating and there may be dysphagia, hoarseness, cough and loss of weight. In one of our cases that had had a radical operation, the mass was found firmly adherent to surrounding structures, including the internal jugular vein. In previous years, when radical excision of the mass was the treat-

## BRANCHIAL ANOMALIES AND NEOPLASMS

ment of choice, intimate adhesion to the internal jugular vein was found almost invariably by von Volkman,<sup>7</sup> Veau<sup>15</sup> and Lorenz.<sup>55</sup>

The prognosis is bad. Three of our cases died of cachexia within a period of two years from the onset of the swelling. There were no observed metastases. The fourth is still alive with a swelling of eighteen months' duration. He has had radiotherapy without improvement. The treatment

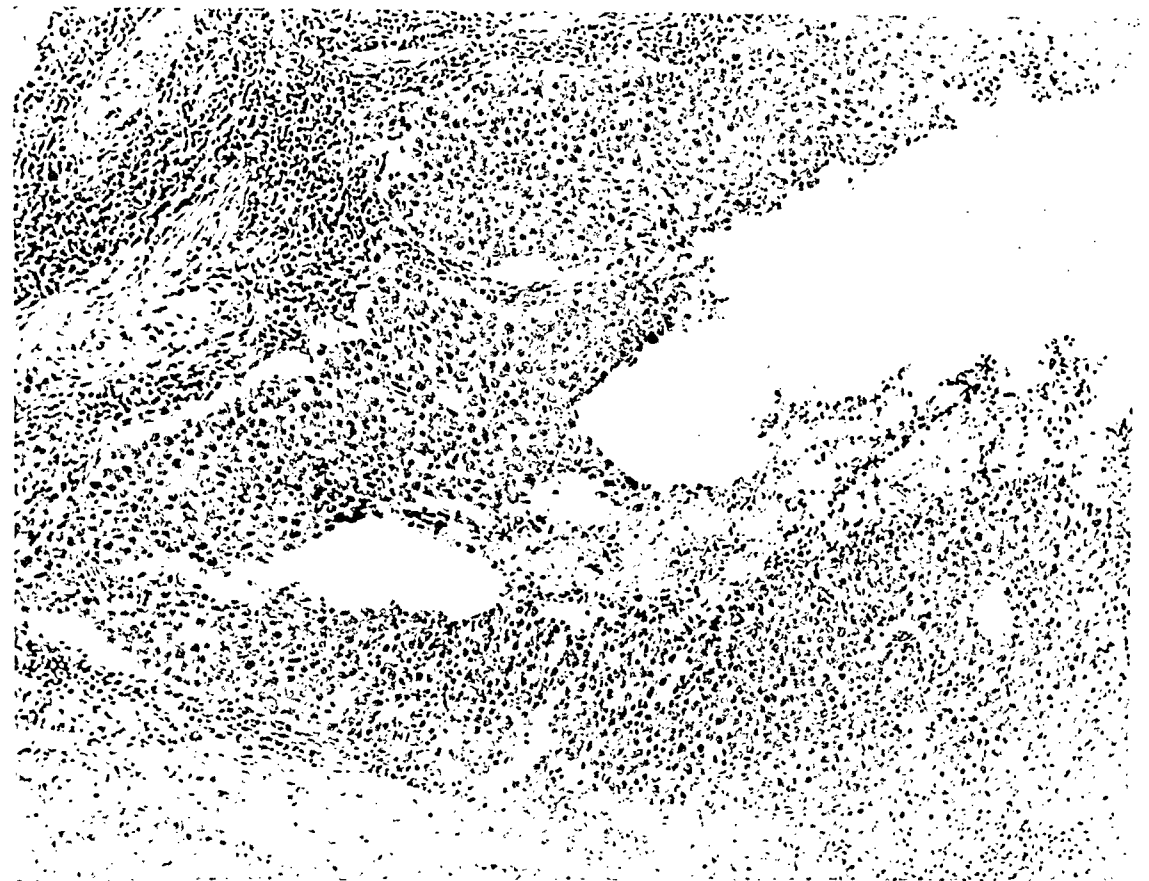


FIG. 13.—Microphotograph of one of the cystic spaces in a branchial epithelioma. It is lined with relatively undifferentiated tumor cells showing many mitoses. The surrounding stroma is densely infiltrated with inflammatory mononuclear cells. (Case history No. 18576).

in the three observed cases varied from radical surgery to X-ray or radium therapy.

A differential diagnosis must be made from tumors of the carotid body, lymph-glands, the antero-inferior portion of the parotid and from an aberrant thyroid.

### ANALYSIS OF TWENTY CASES OF BRANCHIAL CYSTS

#### *Age Occurrence*

Years	No. Cases	Per cent.
1-5 .....	1	5
6-10 .....	2	10
11-20 .....	5	25
21-30 .....	8	40
31-40 .....	2	10
41-50 .....	2	10

# CARP AND STOUT

	Years
Youngest .....	1
Oldest .....	49
Average .....	22

Every male was over twenty years.

<i>Sex</i>	No. Cases	Per cent.
Female .....	13	65
Male .....	7	35

<i>Side</i>		
Left .....	12	60
Right .....	8	40

## *Duration Before Operation*

Shortest .....	3 weeks
Longest .....	4 years
Average .....	11 months

	No. Cases	Per cent.
Cystic or fluctuant .....	12	60
Movable .....	9	45
Location—anterior and beneath sternomastoid .....	17	85

## *Size, when examined (14 cases)*

Largest .....	10 x 8 cm.
Smallest .....	2 x 3 cm.
Average .....	5 x 5 cm.

	No. Cases	Per cent.
<i>Inception</i> with cold or sore throat .....	2	10

## *Pain*

Localized .....	2	10
On swallowing .....	3	15
<i>Continued to drain after incision</i> .....	3	75
<i>Recurrence</i> .....	1	25
<i>Redness of skin</i> .....	1	6

## *Operative Findings*

Extended to great vessels .....	17	85
Deep to great vessels .....	1	5
Superficial to fascia .....	1	5
Not stated .....	1	5
Prolongations to parotid .....	1	
Prolongations to base of skull .....	1	

## *Cyst contents (gross observation)*

Thick pus .....	5	25
Thick amber fluid .....	1	5
Gray turbid fluid .....	2	10
Thin necrotic material .....	1	5
Not stated .....	11	55

<i>Lymph gland involvement</i> .....	10	50
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## *Results*

14 cases were followed:

Shortest follow-up .....	2 months
Longest follow-up .....	51 months
Average follow-up .....	19 months
No recurrences.	



## BRANCHIAL ANOMALIES AND NEOPLASMS

### *Mistaken Diagnoses (in hospital)*

#### Tuberculosis of cervical lymph-glands:

	No. Cases	Per cent.
Pre-operative, alone .....	11	55
Pre-operative and operative .....	7	35

### SYNOPSIS OF TWENTY BRANCHIAL CYSTS

Hospital No. 43364; age, fifty; sex, male; occupation, fireman. Ante-operative duration, twelve months; side, left. Previous operation, none.

*Symptoms and Signs.*—Gradual increase in size of swelling 5 x 8 cm. A soft ovoid fluctuant, movable, encapsulated non-tender mass, anterior to and beneath sternomastoid. X-ray showed shadow in soft tissue.

*Operative Findings.*—A deep purple cyst, 5 cm. in diameter, lay along the anterior margin of the sternomastoid muscle close to the carotid sheath and beneath the angle of the jaw. Excised without rupture. (Dr. John M. Hanford.)

*Pathology.*—Cyst contained a greenish-purple sticky fluid. There was a great deal of lymphoid tissue in the fibrous wall but no epithelial lining could be demonstrated. There was a lymph-node with the cyst.

*Result.*—Two months no recurrence but paralysis of depressor labii inferioris. Twenty-seven months no recurrence, paralysis gone.

Hospital No. 55161; age, twenty-six; sex, male; occupation, letter carrier. Ante-operative duration, three-fourths months; side, right. Previous operation, none.

*Symptoms and Signs.*—Gradual increase in size of swelling. Sometimes size diminishes. Soft, fluctuant swelling 3.5 x 4.5 cm. deep to sternomastoid, movable on deeper structures and under skin.

*Operative Findings.*—Thick-walled cyst, 5 x 2.5 cm. beneath sternomastoid, lying on internal jugular vein, slightly adherent to surrounding structures by fine connective-tissue strands. Cyst dissected out easily. (Dr. John M. Hanford.)

*Pathology.*—Wall varied from 1 to 1.5 mm. in thickness and consisted of dense layer of connective tissue, lined with stratified squamous epithelium 3 or 4 cells deep. Within the connective tissue are mounds of lymphoid tissue. Contents thick, pearly and gelatinous.

*Result.*—Eight months no recurrence.

Hospital No. 62618; age, twenty-one; sex, male; occupation, student. Ante-operative duration, seven months; side, left. Previous operation, none.

*Symptoms and Signs.*—Gradual increase in size of swelling. One month ago had pain on swallowing for one day. In upper deep cervical region cystic swelling beneath sternomastoid 10 x 8 cm. Freely movable.

*Operative Findings.*—Well encapsulated fibrous-walled abscess containing 30-40 c.c. odorless creamy yellow pus. Slightly adherent to surrounding structures. (Dr. John M. Hanford.)

*Pathology.*—Cavity lined with necrotic material and with squamous epithelium. Great deal of lymphoid tissue in thick connective-tissue coat. Many lymph-glands with it showing no evidence of tuberculosis.

*Result.*—Thirty-six months no recurrence.

*Remarks.*—Pre-operative and operative diagnoses were cold abscess.

Hospital No. 48394; age, eight; sex, female; occupation school. Ante-operative duration, one month; side, left. Previous operation, none.

*Symptoms and Signs.*—Gradual increase in size of swelling, situated in upper deep cervical region, 4 x 4 cm.; cystic, movable on deeper structures and under skin.

*Operative Findings.*—Mass of lymph-glands matted together, loosely adherent to surrounding structures. At one part a small amount of yellow, turbid fluid appeared. Boundaries of mass above, angle of jaw; behind, sternomastoid; in front, hyoid bone and anterior facial vein. Great auricular nerve seen and spared. (Dr. John M. Hanford.)

*Pathology.*—Rounded sac 4 x 4 cm. resembling large lymph-gland, filled with thin greenish pus. Inner lining smooth. Wall varied from 3 to 12 mm. in thickness being composed of lymphoid tissue, scar tissue, and squamous epithelial lining.

*Result.*—Five months no recurrence.

*Remarks.*—Pre-operative and operative diagnoses were cold abscess.

Hospital No. 35291; age, nine; sex, female; occupation, school. Ante-operative duration, one month; side, left. Previous operation, none.

*Symptoms and Signs.*—Gradual increase in size of swelling. It was in upper deep cervical region, tense, not attached to skin.

*Operative Findings.*—Diffuse mass situated beneath sternomastoid which contained 15 c.c. of creamy yellow pus. Excised with a mass of lymph-glands. (Dr. J. C. Vaughn.)

*Pathology.*—Rounded mass of tissue 2 cm. in diameter, with a cavity with a roughened red lining, surrounded by firm homogeneous tissue. Cavity lined by squamous epithelium. Separated areas of lymphoid tissue in the wall.

*Result.*—Nine months no recurrence.

*Remarks.*—Pre-operative and operative diagnoses were cold abscess.

Hospital No. 56966; age, fifty; sex, male; occupation, clerk. Ante-operative duration, eighteen months; side, right. Previous operation, none.

*Symptoms and Signs.*—Stationary swelling until three months before admission. Since, gradual increase in size. Globular cystic swelling 2 x 3 cm. below angle of mandible, not attached to skin and attached at one point in region of sternomastoid. Transilluminated.

*Operative Findings.*—Cystic mass excised from beneath level of diaphragm posteriorly. Very few adhesions. (Dr. Mather Cleveland.)

*Pathology.*—Cyst 5 x 3.5 cm. with a wall from .5 to 1 mm. in thickness. Inner surface smooth and in part covered with papillary projections. Lined with stratified squamous epithelium, beneath which were rounded masses of lymphoid tissue causing the papillary projections. There was a lymph-gland with it.

*Result.*—Fifty-one months no recurrence.

Hospital No. 56865; age, twenty-eight; sex, female; occupation, housewife. Ante-operative duration, eighteen months; side, right. Previous operation, incised and drained one and a half years ago for cold abscess.

*Symptoms and Signs.*—Swelling which was incised and drained for three weeks. Then swelling recurred and for three months had been getting larger. In submaxillary region, oval, cystic, fluctuant swelling 6 x 4 x 2 cm.

*Operative Findings.*—Firm walled cyst beneath platysma between sternomastoid internal jugular vein and deep fascia. Few fibrous adhesions to surrounding structures. Contents amber, thick fluid. (Dr. John M. Hanford.)

*Pathology.*—Cyst 3.5 cm. in diameter, wall 1 to 3 mm. thick, lined with a white membrane. This was stratified squamous epithelium, on a connective-tissue base in which was a thick layer of lymphoid tissue.

*Result.*—Eight months no recurrence.

*Remarks.*—It was originally excised for cold abscess and then the cyst recurred.

Hospital No. 57791; age, thirteen; sex, female; occupation, school. Ante-operative duration, six months; side, left. Previous operation, incised two months by private M.D. A tube was left in until one week before admission.

*Symptoms and Signs.*—Swelling six months ago which gradually increased in size. Incised two months ago and still draining. In anterior cervical region at about centre was a fluctuant mass 4 cm. in diameter, attached to skin, slightly movable on deeper parts. At lower margin was a sinus discharging thick yellow pus.

*Operative Findings.*—Sac, encapsulated, anterior to and beneath sternomastoid. Sac and sinus excised. Internal jugular vein and spinal accessory nerve exposed. (Dr. John M. Hanford.)

## BRANCHIAL ANOMALIES AND NEOPLASMS

*Pathology.*—Thick-walled sac  $5.5 \times 4 \times 3.5$  cm. containing a small cavity filled with debris. Cavity lined with stratified squamous epithelium with dense layer of connective tissue containing lymphoid tissue.

*Result.*—Thirty-four months no recurrence.

*Remarks.*—Originally incised and drained and subsequently diagnosed tuberculosis of lymph-glands. Intensive X-ray therapy until operation.

Hospital No. 60683; age, twenty; sex, female; occupation, stenographer. Ante-operative duration, seven months; side, left. Previous operation, none.

*Symptoms and Signs.*—Started with severe cold followed by swelling in neck. Decreased in size in hot weather, but for three weeks had increased in size with slight pain. Vague cystic mass  $4 \times 5$  cm. at angle of jaw, not attached to skin and only slightly to deeper structures.

*Operative Findings.*—Aspiration of cyst gave 20 c.c. of grayish turbid fluid. Cyst lay beneath upper part of sternomastoid. Slightly attached to surrounding structures, especially deep. Excised. (Dr. John M. Hanford.)

*Pathology.*—Ovoid cyst  $5 \times 3.5$  cm. Walls bluish-red, fibrous, varying from .1 to 1 cm. Inner surface smooth, grayish and shiny. The fibrous tissue wall lined with stratified squamous epithelium. One part of wall had lymphoid tissue another had none.

*Result.*—Twenty-one months no recurrence.

*Remarks.*—Pre-operative diagnosis was tuberculosis of lymph-glands with possibility of branchial cyst.

Hospital No. 60655; age, twenty-six; sex, male; occupation, technician. Ante-operative duration three-quarters months; side, right. Previous operation, none.

*Symptoms and Signs.*—Gradual increase in size of swelling with slight redness of skin and slight difficulty in swallowing. In the superior carotid triangle cystic mass  $6 \times 5$  cm., overlapped anterior border of sternomastoid, attached to deeper structures, not attached to skin. Upper border hidden beneath angle of mandible.

*Operative Findings.*—Encapsulated mass  $5 \times 3 \times 3$  cm. containing necrotic material. Excised with surrounding lymph-glands. (Dr. Allen O. Whipple.)

*Pathology.*—Lined with squamous epithelium. Wall thick and fibrous with lymphoid tissue massive in some areas, scanty in others.

*Remarks.*—Pre-operative and operative diagnoses were tuberculosis of lymph-glands.

Hospital No. 68041; age, fourteen; sex, female; occupation, school. Ante-operative duration, two and one-half months; side, left. Previous operation, incised six weeks before by family physician for adenitis.

*Symptoms and Signs.*—Sore throat followed by swelling in neck. Incised because of redness and softening. Closure of wound demanded reopening. Below angle of jaw was swelling  $5 \times 3$  cm., fluctuant, tender, movable on all structures. In centre was sinus tract discharging pus.

*Operative Findings.*—Sinus led into region of upper glands beneath sternomastoid. Mass of glands surrounded tract. Glands and tract excised. (Dr. John M. Hanford.)

*Pathology.*—Mass  $5 \times 3 \times 2.5$  cm. had two cavities filled with pus, surrounded by fibrous tissue. Cavity lined by stratified squamous epithelium, beneath which was large amount of lymphoid tissue. There were short epithelial lined diverticula in wall.

*Result.*—Two months no recurrence.

*Remarks.*—Pre-operative and operative diagnoses were tuberculosis of lymph-glands.

Hospital No. 68118; age, thirty-five; sex, female; occupation, nurse. Ante-operative duration, twenty-four months; side, left. Previous operation, none.

*Symptoms and Signs.*—Swelling barely visible until two and one-half months ago; since then gradual increase in size. Hemispherical fluctuant mass  $4 \times 4$  cm. not attached to surrounding structures.

*Operative Findings.*—Cyst  $3 \times 5$  cm., not very adherent, contained thick, dark, grumous material. It was beneath sternomastoid. (Dr. John M. Hanford.)

*Pathology.*—It had a smooth glistening lining of stratified squamous epithelium

beneath which was thick layer of lymphoid tissue. There were enlarged lymph-glands with it.

*Result.*—Six months no recurrence.

*Remarks.*—Pre-operative diagnosis was tuberculosis of lymph-glands.

Hospital No. 48172; age, thirty-five; sex, female; occupation, housewife. Ante-operative duration, four months; side, left. Previous operation, none.

*Symptoms and Signs.*—Mass gradually increased in size. Under left angle of jaw, smooth, soft, fluctuating mass, slightly movable, size 4 cm. in diameter.

*Operative Findings.*—Under left angle of jaw was mass of enlarged broken down glands. It was attached to submaxillary gland and extended up to ear. Freed from carotid, internal and external jugular veins. (Dr. Clarence A. McWilliams.)

*Pathology.*—Irregular fibrous mass 3 x 2 x 1 cm. with a collapsed cyst in it lined with squamous epithelium covering fibrous tissue in which were masses of lymph follicles. About it were lymph-glands which showed chronic inflammation.

*Remarks.*—Pre-operative and operative diagnoses, tuberculosis of lymph-glands.

Hospital No. 21507; age, twenty-three; sex, male; occupation, steam fitter. Ante-operative duration, fifteen months; side, right. Previous operation, none.

*Symptoms and Signs.*—Mass gradually increased in size until three months ago when it grew rapidly larger. In submaxillary region was soft, fluctuant rounded swelling 4 cm. in diameter.

*Operative Findings.*—Discrete thin-walled cyst under deep fascia and anterior to sternomastoid, slightly adherent to surrounding structures. It was oval and contained a thin turbid fluid like sebaceous material found in dermoid cyst. (Dr. E. Eliot, Jr.)

*Pathology.*—Thin-walled sac 5 cm. in diameter .2 cm. in thickness. The inner surface was slightly granular, lined by stratified squamous epithelium. Outside of this was a large amount of lymphoid tissue.

*Result.*—Seventeen months no recurrence.

Hospital No. 23027; age, sixteen; sex, female; occupation, school. Ante-operative duration, forty-eight months; side, left. Previous operation, none.

*Symptoms and Signs.*—Swelling size cherry which stood out on twisting neck to right. Gradual increase in size. Mass in anterior triangle of neck 5 x 5 cm., soft, fluctuant, not attached to skin or deeper parts.

*Operative Findings.*—Discrete mass, under platysma and lying on great vessels, with one prolongation attached to parotid gland. (Dr. Clarence A. McWilliams.)

*Pathology.*—Mass 4 x 4 cm.; surface covered by fine adhesions. Cavity filled with light, yellow, cheesy material. Lined by squamous epithelium beneath which was a thick layer of lymphoid and connective tissue.

*Result.*—Twelve months no recurrence.

Hospital No. 23482; age, five; sex, female; occupation, child. Ante-operative duration, forty-eight months; side, left. Previous operation, thirteen weeks ago incision and drainage by family doctor.

*Symptoms and Signs.*—Swelling gradually increased in size until operation thirteen weeks ago. Since then there had been intermittent discharge of yellow purulent material. Occasionally cyst filled and became painful. Just to left of midline in lower anterior triangle was a tiny dry reddened sinus mouth.

*Operative Findings.*—Sinus extended downward beneath the skin about 2.5 cm. and upward 1 cm., entering a cyst about size of hazel nut. The inferior portion was closely adherent to sheath of great vessels, where it ended blindly. (Dr. E. Eliot, Jr.)

*Pathology.*—Cyst and tract lined with squamous epithelium beneath which was thick layer of lymphoid and connective tissue. There were short diverticula in the wall lined with similar epithelium.

*Result.*—Twenty-four months no recurrence.

Hospital No. 77179D; age, twenty-three; sex, female; occupation, housewife. Ante-operative duration, two months; side, left. Previous operation, none.

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*Symptoms and Signs.*—Swelling had gradually increased in size and at times caused difficulty in swallowing. In carotid triangle was firm, rounded, loosely attached mass beneath the sternomastoid anteriorly.

*Operative Findings.*—Beneath the mesial border of sternomastoid and adherent to it was a moderately firm, yellowish mass adherent also to big vessels. It was cystic and contained thick yellowish material. (Dr. Dudley Morris.)

*Pathology.*—Sac is 18 mm. in diameter and 2 mm. in thickness lined with finely granular contents. The lining was stratified squamous epithelium beneath which was a thick layer of lymphoid tissue. Outside of this was a dense layer of stratified connective tissue.

Hospital No. 71663D; age, thirteen; sex, female; occupation, school. Ante-operative duration, two months; side, right. Previous operation, none.

*Symptoms and Signs.*—Swelling had gradually increased in size.

*Operative Findings.*—Cystic mass in carotid triangle, attached to great vessels and beneath hyoid. Cyst filled with thin, necrotic material. (Dr. Dudley Morris.)

*Pathology.*—It was lined with stratified squamous epithelium and had lymphoid tissue in wall.

Hospital No. 69424; age, twenty-six; sex, male; occupation, car tracer. Ante-operative duration, three months; side, right. Previous operation, none.

*Symptoms and Signs.*—Sudden appearance of swelling which had gradually increased. In upper half of neck was 7 x 8 cm. cystic movable swelling, underneath anterior border of sternomastoid. It extended to midline and level of thyroid cartilage and lower border of jaw.

*Operative Findings.*—Soft encapsulated cyst 6 x 6 cm. filled with creamy yellowish fluid. It lay under the anterior border of the sternomastoid, over the scalene muscles, behind the sheath of the internal jugular; the upper border was on the posterior belly of the digastric. (Dr. John M. Hanford.)

*Pathology.*—Cyst was 5 x 2.5 x 2.5 cm. lined with smooth, shiny, stratified, squamous epithelium beneath which was a thick layer of lymphoid tissue. One lymph-gland attached to capsule.

Hospital No. 69638; age, twenty-three; sex, female; occupation, housewife. Ante-operative duration, two months; side, right. Previous operation, none.

*Symptoms and Signs.*—Sudden appearance of swelling size of moth ball which has gradually increased in size. Very recently there has been slight boring pain in swelling. In upper cervical region, underneath sternomastoid, was 6 x 4 cm. faintly cystic, movable mass.

*Operative Findings.*—Cyst lay under the upper end of sternomastoid, projecting slightly in front and back of it. The upper end was against the transverse process of the atlas. There were a few firm adhesions. The cyst extended down to the junction of the facial vein with the internal jugular vein. The spinal accessory nerve was adherent to the posterior-superior surface of the cyst. (Dr. John M. Hanford.)

*Pathology.*—A partly collapsed cyst 4 cm. long with walls 4 mm. thick and containing 10 c.c. of thick pallid semipurulent material. A smear of this showed many pus cells, flat epithelial cells and a few cholesterol crystals. It was lined with squamous epithelium and granulation tissue and had a few germinal centres in the thick fibrous wall. Two small lymph-nodes were with it.

*Remarks.*—Pre-operative and operative diagnoses—tuberculosis of lymph-glands.

## SYNOPSIS OF FOUR BRANCHIAL FISTULAS

Hospital No. 34499; age, seven; sex, female; occupation, school. Ante-operative duration, congenital; side, bilateral. Previous operation, none.

*Symptoms and Signs.*—Since birth bilateral pinhead-sized openings in neck at level of thyroid cartilage; five years ago swelling appeared around the opening on right and this had gradually enlarged. Three years ago mucoid, clear discharge appeared here

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which later became purulent. The left side discharged occasionally. Often tasted foul material. On either side of thyroid cartilage, near midline was a pin-hole opening. On the right it was surrounded by 2 x 6 cm. swelling which on squeezing exuded thick pus.

*Operative Findings.*—Fistulous tract superficial at first and then ran under sternomastoid. An inserted probe came out above and behind tonsil. Tract completely excised. (Dr. Clarence A. McWilliams.)

*Pathology.*—The tract was lined with stratified epithelium and surrounded by lymphoid tissue. It passed through striated muscle and had numerous diverticula passing out into the muscle. In the muscle close to the wall at one point was a group of serous glands (similar to the ones found in the capsule of the tonsil). Here near the pharyngeal end of the tract the epithelium was stratified columnar like the pharyngeal epithelium.

*Result.*—Ten years no recurrence.

*Remarks.*—Bilateral, right—complete. Patient's father, brother and female cousin on father's side, and paternal grandfather, all have bilateral cervical fistulas. Another brother (Case No. 69573) has branchial appendage and cleft palate.

Hospital No. 65546; age, eleven; sex, female; occupation, school. Ante-operative duration, congenital; side, right. Previous operation, none.

*Symptoms and Signs.*—Since birth pin-hole opening in the right side of neck; nine years ago it discharged a little pus when she had pneumonia. Opening had persisted with slight discharge and two weeks ago tender, red swelling appeared around opening, discharging thick, greenish pus. Two centimetres above inner end of sternomastoid at its anterior border was a globular cystic 1 x 1 cm. swelling. No deep tract can be felt.

*Operative Findings.*—A probe passed into opening went to lower margin of mandible. The tract surrounded by thick fibrous tissue, except at inner end, where it was very friable. Most of tract was superficial to deep cervical fascia. Its upper end was close to the cornu of the hyoid. Inner end of tract tore off and it was carbolized. (Dr. John M. Hanford.)

*Pathology.*—Tract was 4.5 cm. long. The soft lining was plicated, practically occluding it. The wall varied in thickness from .1 to .2 cm. The tract was lined by stratified columnar epithelium with a dense layer of lymphoid tissue about it.

*Result.*—Sixteen months no recurrence.

*Remarks.*—External incomplete.

Hospital No. P. P.; age, five; sex, male; occupation, school. Ante-operative duration, congenital; side, right. Previous operation, none.

*Symptoms and Signs.*—At birth a pinhead-sized pimple noticed on right side of neck. Three years ago swelling opened and discharged small amount of mucoid material. Since then the fistula closed and opened intermittently, the discharge being more profuse when the child had a cold. Occasionally a small swelling formed about the opening. For two years had a dry cough worse at night, and when the sinus was not discharging. At anterior border of right sternomastoid about 3 cm. above sternoclavicular junction was soft, non-tender, fluctuating cystic mass, 3 mm. in diameter, with a pinhead, reddish area in the centre. Cystic mass became a little larger on coughing.

*Operative Findings.*—The tract went through platysma, sheath of sternomastoid and carotid sheath between the carotid artery, internal jugular vein and vagus nerve. It was in intimate contact with the vagus for a short distance and slightly adherent to it at one point. It then coursed obliquely upward and backward to the pharynx, where it ended blindly. The pharyngeal end was thin and friable. (Dr. Louis Carp.)

*Pathology.*—The excised tissue 3 cm. long was fibrous and muscular and had a narrow tract containing mucoid material passing through it. The tract was lined with stratified squamous epithelium with a great deal of lymphoid tissue immediately surrounding. It passed through a mass of striated muscle in which were several groups of nerve fibrils.

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*Result.*—Day of operation cough stopped; twenty-four months no recurrence or cough. Forty-eight months no recurrence or cough.

*Remarks.*—Incomplete external. Symptoms of vagus nerve irritation.

Hospital No. 69188; age, eight; sex, female; occupation, school. Ante-operative duration, congenital; side, left. Previous operation, none.

*Symptoms and Signs.*—At birth small opening just to left of midline in lower part of neck. Since tonsillectomy five years ago had discharged "pus". There was a sticking pain locally and on swallowing. There was slight swelling around opening when it closed. There was about one-half teaspoonful discharge a day. Opening just below level of cricoid along anterior margin of sternomastoid. Tract could be felt a few centimetres under skin upward. No opening in pharynx.

*Operative Findings.*—Fluid in injected sinus came out in pharynx. The tract extended upward beneath tendon of digastric muscle and hypoglossal nerve and then dipped down to pharynx. The tract was dissected out to this point. Stump carbolized and sewn over. (Dr. Frank L. Meleney.)

*Pathology.*—Elongated mass of purplish tissue 5.5 cm. in length. At one end was an elliptical piece of skin with a 2 mm. opening in the centre. The wall of the tract was white and 1 mm. thick. Tube surrounded by thin layer of fibrous tissue in which were patches of lymphoid tissue and directly outside of this striated muscle. In one part the tube was lined by stratified squamous epithelium and near the pharyngeal end by stratified columnar epithelium.

*Remarks.*—Complete fistula.

*Result.*—Seven months—no recurrence.

## SYNOPSIS OF FOUR BRANCHIAL APPENDAGES

Hospital No. 69973; age, twenty; sex, male; occupation, farmer. Ante-operative duration, congenital; side, left. Previous operation, none.

*Symptoms and Signs.*—Presence of mass in lower anterior part of neck 2 cm. above sternoclavicular junction. At anterior border of sternomastoid was a pinhead-sized dimple beneath which was an irregular cartilaginous flexible mass 2 cm. in diameter attached to skin and apparently to the anterior border of the sternomastoid.

*Operative Findings.*—The mass was adherent to the skin and the sternomastoid. It contained cartilage with a few sharp projections. The cartilage lay between the platysma and the tendon of the sternomastoid muscle. (Dr. William Barclay Parsons, Jr.)

*Pathology.*—The cartilage was of the elastic type like that of the auricle. It was surrounded by perichondrium and the dimple in the skin was due apparently to close attachment of skin to perichondrium. There was evidence of cartilage proliferation at one point on the periphery.

*Remarks.*—Operated on for cleft palate in infancy. Has right congenital inguinal hernia. (This patient is brother of Case No. 34499.)

Hospital No. 37556; age, seventeen months; sex, male; occupation, infant. Ante-operative duration, congenital; side, left. Previous operation, none.

*Symptoms and Signs.*—Mass present since birth, had not increased in size. In left side of neck over centre of sternomastoid at anterior border was a rounded, soft, protruding mass 2 cm. in diameter. A cord-like structure ran from it toward the midline where it became lost.

*Operative Findings.*—On opening subcutaneous tissue a bar of cartilage 1 cm. long was found which passed backward and outward. It did not connect with a cyst or cleft. (Dr. Allen O. Whipple.)

*Pathology.*—Nipple-shaped mass 1 x 1.5 cm. covered by normal hairy skin and subcutaneous fat. In the centre was an oval mass of fibrocartilage 1 x 2 mm.

*Result.*—Two months no recurrence.

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Hospital No. 137795D; age, five; sex, female; occupation, child. Ante-operative duration, congenital; side, left. Previous operation none.

*Symptoms and Signs.*—Growth had gradually increased in size. In front of ear and attached to tragus is a bilobed, cartilaginous growth, freely movable.

*Operative Findings.*—Excision. (Dr. John M. Hanford.)

*Pathology.*—The growth is normal hair-bearing skin and subcutaneous fat 7 mm. long with a bar of fibrocartilage 1 mm. in its centre.

*Result.*—Twenty-four months no recurrence.

Hospital No. 67433; age, twenty-six; sex, male; occupation, shipping clerk. Ante-operative duration, congenital; side, left. Previous operation, none.

*Symptoms and Signs.*—Gradual increase in size. Prominent nipple-like projection 1.5 cm. long in left lower anterior triangle of neck. It was stiffened by a firm cartilage-like central bar which extended subcutaneously.

*Operative Findings.*—Mass covered with skin and subcutaneous tissue and in its centre was a stiff bar of cartilage. It was adherent to platysma. (Dr. C. L. Janssen.)

*Pathology.*—Gross specimen was lost.

## SYNOPSIS OF FOUR BRANCHIAL EPITHELIOMAS

Hospital No. 35740; age, fifty-one; sex, male; occupation, cleaner. Ante-operative duration, two months; side, right. Previous operation, incision and drainage of mass above the present one fifteen years ago. Drained for one year.

*Symptoms and Signs.*—Swelling increased in size rapidly and at times decreased. Recently pain, redness, tenderness and softness. Mass was ovoid, extended from midline outward 10 cm. and was 7 cm. vertically adherent to all structures, surface coarsely nodular, hard and fluctuant in lower portion.

*Operative Findings.*—Mass composed of firm but friable tissue separating numerous cystic cavities which contained a small amount of cloudy fluid under slight tension. Exploration and biopsy. (Dr. James A. Corscaden.)

*Pathology.*—An invasive tumor forming cyst-like spaces with papillary projections lined with squamous epithelial tumor cells and mitoses averaged two to every high power field. Little differentiation and no tendency to pearl formation.

*Result.*—Four months, died (cachexia).

Hospital No. 18576, 20026, 23080; age, sixty-seven; sex, male; occupation, laborer. Ante-operative duration, six months; side, right. Previous operation, none.

*Symptoms and Signs.*—Growth increased rapidly in last three months, forming a sinus discharging cheesy material. When sinus closed mass grew larger. A firm fluctuant mass 5 x 5 cm. attached to reddened skin and deeper structures.

*Operative Findings.*—Mass 5 x 5 cm. firmly adherent to surrounding structures and internal jugular vein. A prolongation ran back to the base of the skull. (Dr. Clarence A. McWilliams.)

*Pathology.*—A relatively undifferentiated neoplasm composed of strands of cuboidal and squamous cells with a tendency to necrosis, mitoses averaged three to every high power field. It tended to form small cystic spaces with papillary projections into them lined with tumor cells.

*Result.*—Six months local reappearance, exuberant granulations and foul odor. Excised, seven months post-operative; wound healed and health improved. Nine months reappearance, again excised. X-ray therapy, twenty-four months; died (cachexia).

Hospital No. 23511; age, forty-two; sex, male; occupation, waiter. Ante-operative duration, one month; side, left. Previous operation, none.

*Symptoms and Signs.*—Growth started as size of plum; had not increased in size. For one week it had been painful and for three days there had been difficulty in swallowing. In front of sternomastoid about in centre was a hard mass 5 x 2 x 3 cm. attached to deeper structures but not to skin.



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*Operative Findings.*—Mass size of egg firmly adherent to sternomastoid. Hard and infiltrating specimen excised. (Dr. George E. Brewer.)

*Pathology.*—Relatively undifferentiated squamous cells. There was a tendency to form small cystic spaces with papillary projections into them—lined with tumor cells. Mitoses average one to every high power field. Spaces *not* due apparently to necrosis of cells as there are no necrotic cells in them and the lining has not degenerated.

*Result.*—Two months lost ten pounds. Mass larger in eight months, losing weight and strength in spite of X-ray therapy. Wound discharging. Nine months, died (cachexia).

Hospital No. 96387; age, sixty; sex, male; occupation milling. Ante-operative duration, twelve months; side, right. Previous operation, none.

*Symptoms and Signs.*—Swelling size of marble, which had gradually increased in size. Severe pain radiating to scalp and behind ear for four months. Recently voice hoarse, dry cough, loss of weight. Emaciated man in pain. Nose, pharyngeal examination negative. Swelling 9.5 x 4.5 cm. projected 3 cm. over middle of sternomastoid and extended into anterior triangle of neck. Nodular firmly adherent and anteriorly an area of softening.

*Operative Findings.*—Biopsy—softened area contained thick pus. (Dr. Louis Carp.)

*Pathology.*—The growth made up of epithelial-cell masses with only slight tendency to differentiation and pearl formation. Some collapsed cysts lined with many layers of squamous tumor cells. Few mitoses.

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# CERTAIN EFFECTS OF OBSTRUCTION OF THE BILE DUCTS\*

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THE gross and microscopic anatomy of the biliary system has been studied by many investigators since the time of Kiernan in 1833. His thesis on the anatomy and physiology of the liver gave the first comprehensive description of its intimate structure and functional activity. He gave particular attention to the ultimate connection of the bile-ducts with the hepatic cells, and made his observations by means of a hand lens and injection of the biliary system with cinnabar and oil of turpentine.

Grossly he divided the biliary system into the gall-bladder, the common and the cystic ducts, the common hepatic and the right and left hepatic ducts, which divided and subdivided until they united with the hepatic cell columns. The ducts diminished in diameter from the common duct, which averaged approximately 5 mm., to the terminal branches measuring 0.2 mm. in diameter.

He described a few accessory gland-like structures found lying entirely within the walls of the ducts, communicating with the lumen by numerous minute orifices. In the pig, sheep and horse they surrounded the wall completely, anastomosing within it, and opening on the lumen from all sides. In man, however, they were arranged in two rows on opposite sides of the ducts with the orifices preserving the same relationship. Theile, in 1840, by means of similar injections observed that these structures consisted of branching clusters terminating frequently in small cæcal diverticula. He considered them mucous glands, comparable to the meibomian glands of the eye.

Beale in 1856<sup>3</sup> and again in 1889,<sup>4</sup> after extensive researches devoted to the subject, confirmed and extended the observations of Kiernan and Theile. Like Kiernan his attention was centred especially on the bile-ducts and on their connections with the hepatic cells. He measured the bile-ducts throughout the descending order of branches and showed that their terminations were directly continuous with the columns of hepatic cells which he stated lay within a cell-containing membrane. The portion of the duct which joined the terminal bile-duct to the cell-containing membrane was 0.003 of an inch in diameter and was the weakest point in the entire biliary system. This portion was devoid of epithelium and was extremely likely to rupture even with the most gentle manipulation.

Beale called the mucous glands of Kiernan and Theile parietal sacculi, considering them epithelial rather than mucous glands. He found that they occurred in the common and hepatic ducts and in all of the intrahepatic branches as far as those measuring 1/125 of an inch in diameter. He found, also, that while anastomosis between parietal sacculi frequently occurred within the walls of the ducts, quite as often it took place outside them and within the parenchyma of the liver by means of irregular canals springing from the terminal cecal diverticula.

This extraductal network of canals was also noted by Weber, who named them vasa aberrantia. Kölliker described them as existing (1) in the left triangular ligament as six to ten or more canals measuring 0.006 to 0.027 inch in diameter, anastomosing in

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loops and consisting of a basement membrane lined with small cuboidal cells; (2) in the membranous bridge which unites the spigelian and right lobes behind the inferior vena cava, in the membranous band which frequently covers the umbilical vein, and at the edge of the cystic fossa, and (3) in the transverse fissure of the liver. Here they are most prominent and arise from the right and left hepatic ducts as numerous fine branches, distributed through the connective tissue of the capsule of Glisson, covering the fossa and forming a network which unites the two branches within the liver. Weber considered them aberrant biliary ducts, their function being to bring the bile into closer communication with the venous and arterial vaginal plexus for the purpose of concentration. Toldt and Zuckerkandl, on the other hand, believe these structures represent the ductal remains of degenerated hepatic parenchyma.

However, partial sacculi and vasa aberrantia assume importance if considered in the light of the work of Sweet, who recently reviewed the work of Beale and added a further contribution to the subject. If, according to the hypothesis of Beale, these structures were to be considered as small gall-bladders, then they should show some change, either functional or anatomic following cholecystectomy. In animals without the gall-bladder, such as the horse, Sweet found the sacculi to be large and numerous, whereas in animals with gall-bladders, they were flattened and inconspicuous. In dogs after cholecystectomy he noted an immediate rise in blood cholesterol which returned to normal after forty days. Coincident with the fall in blood cholesterol the parietal sacculi enlarged and became hypertrophied. He therefore believed that these structures took over the function of absorbing cholesterol from the bile which Boyd has demonstrated in the normal gall-bladder, in other words, that the parietal sacculi were actually subsidiary gall-bladders.

The bile-ducts ramify in the portal canals surrounded by Glisson's capsule. Each branch is accompanied by a branch of the hepatic artery and portal vein. According to Mall the intrahepatic branches are divided into at most six orders, the terminal branches arising from the fourth, fifth and sixth.

The biliary tree is of tremendous importance in obstructive lesions, since any obstruction to the common duct will affect the entire system.

The effect of lesions of the gall-bladder and ducts on the liver has been known for many years. However, a determination by actual measurement of the variation in size of the entire biliary tree under such conditions has not been made so far as I can discover.

Frerichs, in 1858, made the first comprehensive study of the subject and his conclusions have in the main been confirmed by subsequent investigators. Wyes and Leyden tied off the common bile-ducts in cats and dogs, and observed the resulting dilatation of the biliary passages with the associated fatty changes in the hepatic cells. Mayer, in 1872, repeating this work, obtained the same results, but also found atrophy of the hepatic cells together with lymphocytic infiltration of the parenchyma. In the same type of experiment, Legg, in 1873, noted among the earliest clinical phenomena, emaciation and jaundice. Dilatation of the ducts extending to the smallest radicles was seen, and a marked increase in the connective tissue surrounding them. From the absence of glycogen in the cells he concluded that the glycogenic function of the liver was soon lost. This work was extended by Harley and Barratt, who ligated the left hepatic bile-duct in a number of cats and found that there was scarcely any gross change in the biliary system within four months. After six months, however, the capsule was wrinkled and the lobules were more prominent on the left than on the right. After twelve months there was marked atrophy of the left lobe and considerable superficial scarring. The bile-ducts were dilated throughout their course, were tortuous, varicose, and filled with

viscid yellowish fluid. Microscopically, atrophy of the hepatic cells was visible with marked deposition of fibrous tissue at the terminal bile-ducts and proliferation of the finest terminal branches. In short, cirrhosis had resulted from chronic obstruction of the ducts. More recently, Rous and Larimore<sup>22</sup> have extended these experimental observations.

In regard to the liver of man, Ford and Weber were among the earliest to draw attention to the changes occurring in the bile-ducts and parenchyma from obstruction due to stone, confirming in general the results obtained by experiments on animals.

In this study I wish to show the extent of the injury in various types of obstruction by means of actual measurement of the ducts. The celloidin-injection and corrosion method, which has been used, is one which lends itself particularly well to the purpose. It was often employed by earlier anatomists in the demonstration of the vascular systems of normal structures and occasionally of diseased organs, although not so often as its usefulness warranted. More recently it has been applied to the kidney by Golubew, Brödel, Hinman, Morison and Brown; to the lungs by Marquis, and to the submaxillary glands by Flint and Marshall. The specimen so produced is easily studied, and forms a valuable addition to any pathologic museum, especially if exhibited along with the gross specimens preserved by the usual methods.

The material for study was obtained from subjects at necropsy. For comparison, normal livers were injected and casts made of the biliary trees. A number of livers affected by various lesions of the biliary tract were then obtained and similar preparations made. Four series of preparations have been made: one showing the normal, one the effect of various grades of cholecystitis, one of cholecystectomy and one of benign and malignant strictures of the common duct.

The method has been that used by Hinman, Morison and Brown with certain important modifications. As soon after death as possible the liver is dissected from the abdomen with the diaphragm and as much of the superior and inferior vena cava as possible. The gastrohepatic omentum, containing the portal vein, hepatic artery, and bile-duct, is severed close to the duodenum. Great care is taken not to injure the capsule of the liver at any situation, or leakage will occur. Cannulas with as wide a lumen as possible are then placed in the portal vein and common duct, and a stab hole made in the fundus of the gall-bladder.

The portal vein is connected by rubber tubing to an ordinary cold water faucet and the liver immersed in a tank of cold water. The tap is gradually turned on until there is a free flow from the hepatic veins and the liver is tense almost to the bursting point. I have not found it necessary to use an isotonic solution in washing the organ before injection of either the bile-ducts or blood-vessels, ice cold water being entirely satisfactory. Washing is carried on for varying periods up to twelve hours. It is difficult to remove the bile from the system of blindly ending ducts, but satisfactory casts can be obtained only when this has been successfully accomplished. The high pressure within the capsule is used, first, to squeeze out as much bile as possible, and second, to cause the water to filter through into the ducts and

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wash out the viscid material. Puncturing the gall-bladder prevents over-distention of that organ. When washing is complete the liver is removed from the tank and wrapped in towels; weights up to fifteen pounds are then laid on it. The towels are changed frequently so that in a few hours the accumulated fluid is pressed out and the organ assumes a shrunken appearance and clay-like consistence. This method was first advocated by Beale, and with it I have been able to produce improved specimens.

The cystic duct is next clamped off and the liver connected to the injection apparatus (Fig. 1). This consists of a gas cylinder *A*, connected through

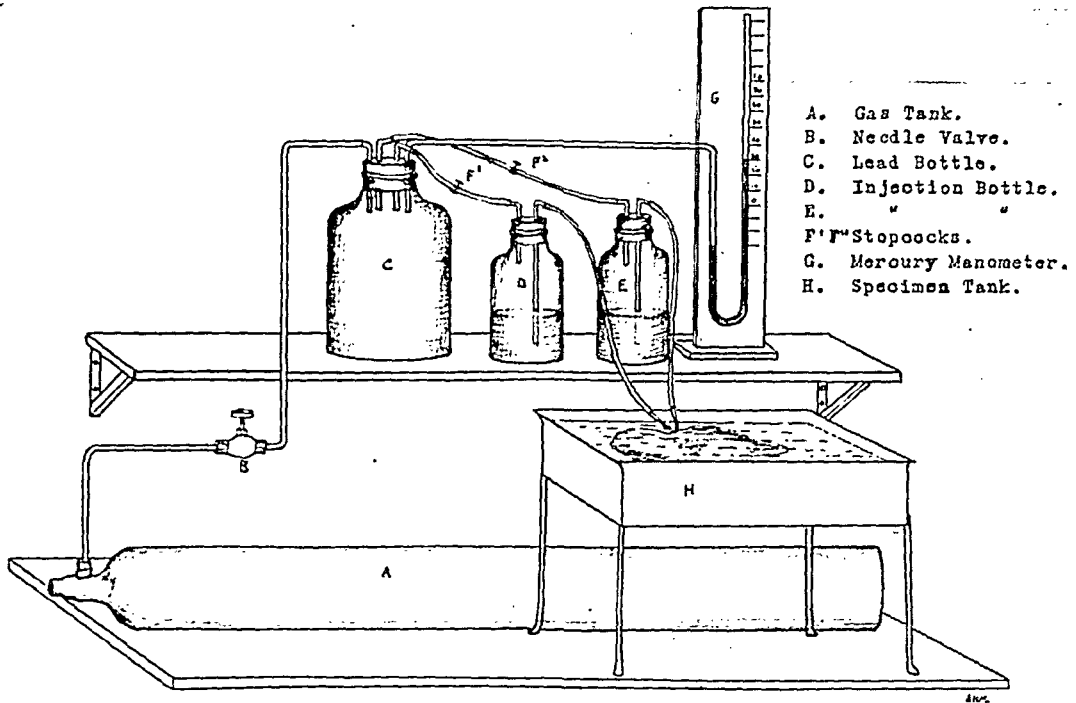


FIG. 1.—Injection apparatus.

a needle valve *B* to a lead bottle *C*. To this any number of injection bottles *D* and *E*, containing injection fluid can be connected, according to the number of vessels to be injected. A manometer *G* records the pressure. The injection fluid consists of a solution of celloidin in acetone prepared according to the method of Hinman, Morison and Brown. Although I keep the stock solutions as recommended by them, I do not use any fixed dilution for injection, but vary it according to the vessel to be injected and the types of injection required. Experience will determine the most suitable consistence. For the bile-ducts I find that a preliminary injection of colloidin of so watery a consistence that it drips easily from a glass rod, followed by one of the consistence of thick cream, gives satisfactory results. I have discarded the dyes commonly used as coloring agents, since I have found artists' oil paints of any standard quality superior, particularly in the smaller branches where an opaque bright permanent color is desirable.

Before the tube from the injection bottle is connected to the cannula, it should be filled with fluid to exclude as much air as possible. All connections

are then made tight and the pressure rapidly raised to 360 mm. of mercury and maintained at that level for six hours. At the end of this time the thick solution is substituted for the thin and injection proceeded with for another period of from twenty-four to thirty-six hours at a pressure of 200 mm. At the same time a slow stream of cold water is run through the portal vein in order to wash out the accumulated acetone and facilitate the hardening of the celloidin in the smaller branches. The long period of injection serves the purpose of filling all the branches completely, so producing a solid cast, and at the same time prevents shrinkage which might take place if hardening occurred after the pressure was released. Sections for microscopic examination can be taken at any time after the medium in the smaller branches is set.

By palpating the common duct one can judge how hardening is progressing; as soon as it is considered complete the liver is removed from the tank and immersed in concentrated hydrochloric acid for from four to five days. The parenchyma is rapidly corroded; any material adhering to the branches of the bile-duct is washed away with a fine stream of cold water. A perfect specimen including the cast of the parietal sacculi and vasa aberrantia should be produced. The specimen should be mounted on a sheet of glass perforated with small holes, through which the branches can be secured with fine thread. It is then sealed in a jar containing a sprinkling of camphor on the bottom covered by a sheet of wet blotting paper, according to the method of Lundquist and Robertson. By this means the celloidin is prevented from drying and becoming brittle.

*Results of Study.*—In all, twenty-six livers of the four types previously mentioned, were treated in this way. In one instance of malignant stricture of the duct a double injection of the portal vein and bile-duct was made. The calibre of the ducts was measured as accurately as possible with fine external calipers and a screw gauge. Although shrinkage has been eliminated as much as possible by hardening the cast under long-continued pressure, there is no doubt that a certain amount occurred, but it was so slight as to be practically negligible. Since this factor can be taken as constant throughout, the method and conditions being identical for all cases, the measurements afford a good index of the changes in internal diameter of the common hepatic ducts, right and left hepatic ducts, and branches of the first, second, third, fourth and fifth orders.

A thorough study of the casts of ten biliary trees from normal livers was first carried out in order to establish a criterion for the comparison of normal types. (Fig. 2.) The common and hepatic ducts form a comparatively slender trunk varying in diameter from 2.1 to 4.8 mm. Five millimetres was therefore taken as the greatest normal diameter in these passages. Within the hilum of the liver the common hepatic duct divides into right and left branches and these in turn form five or six smaller branches. By a descending order of divisions, diminishing in size but increasing in number, the remainder of the tree is built up until at the fifth order the ducts have become mere filaments. The right hepatic duct varies in diameter from 1.6



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to 3.4 mm., the left from 1.4 to 3.6 mm. Sometimes the left duct is wider than the right, although the reverse is more often true. Branches of the first order vary from 1.1 to 2.2 mm. in diameter, those of the second from 0.8 to 1.5 mm., those of the third from 0.3 to 0.8 mm., those of the fourth from 0.1 to 0.3 mm., and those of the fifth from 0.05 to 0.1 mm. (Table I.)

So far as the ducts themselves are concerned and exclusive of the vasa aberrantia, no anastomosis between the two sides was found as far out as the fifth order of branches, a condition which was also demonstrated in the portal

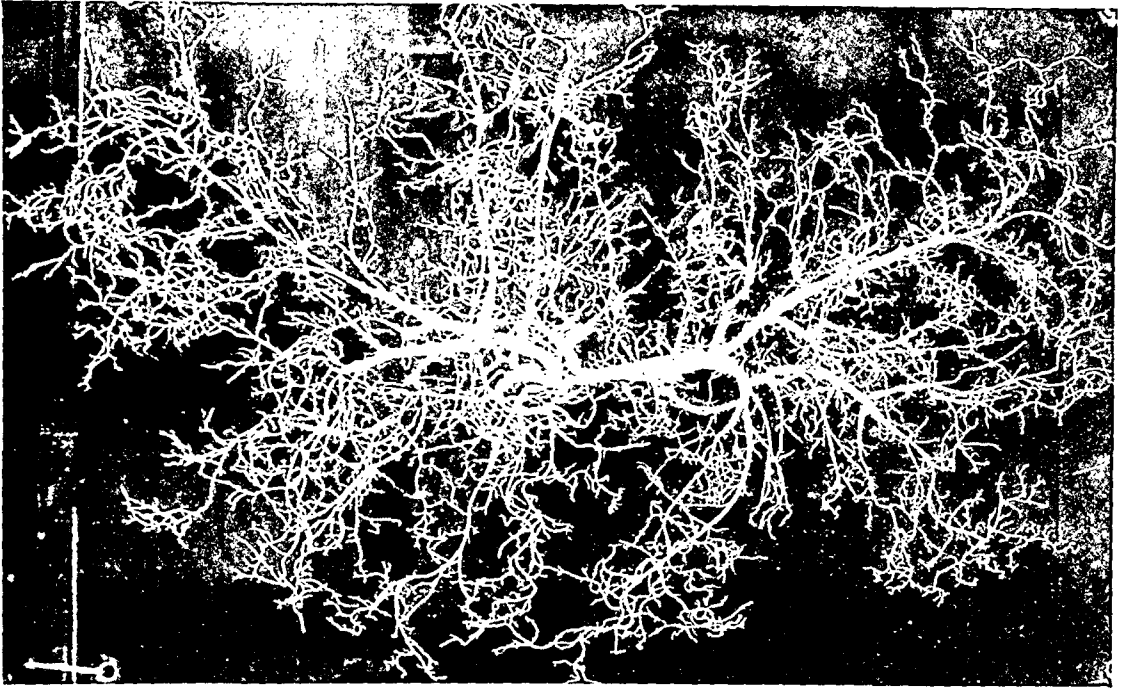


FIG. 2.—Normal biliary tree.

vein. That is to say, outside the bile canalicular and capillary anastomosis there is no gross anastomosis between the right and left branches of bile-ducts or portal vein. In the case of the hepatic artery, an anastomosis of arterioles from side to side is usually established (McIndoe).

As Mall has shown, the finest bile-ducts are given off from the fourth and fifth order of branchings onward. In some of the injections as many as six orders could be counted, although many terminated at the fourth division. It can, therefore, be assumed that the celloidin has penetrated to at least within one branch of the hepatic columns or just proximal to those finer ducts which undergo such marked proliferation in cases of obstructive biliary cirrhosis. The ducts at this point were estimated by Beale to measure from 0.1 to 0.2 mm., which conforms quite accurately to the gross measurements which I have made.

The vasa aberrantia and parietal sacculi are demonstrated by this method and are revealed as a number of anastomosing tubules arising from opposite sides of the ducts and appearing as tortuous, curled, branching processes ending frequently in cap-like dilatations. In the transverse fissure they form a slight anastomosis between the right and left hepatic ducts. The

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parietal sacculi sprout from the opposite sides of the lumen, and within the wall form an anastomosing cluster of small vessels dilated at the distal ends, and frequently connected with the vasa aberrantia. It is rather curious that practically all the branches of the biliary tree and the vasa aberrantia arise from opposite sides of the duct along the lines of the parietal sacculi. In general, therefore, the wall of the duct has two smooth surfaces separated

TABLE I.  
*Dimensions of Normal Biliary Tree.*

Case	Age, sex	Diagnosis	Diameter of ducts, mm.							
			Hepatic			Successive branches in descending order				
			Common	Left	Right	First	Second	Third	Fourth	Fifth
1	25 F	Placenta previa.....	4.0	3.5	3.0	2.1	1.5	0.7	0.1	0.05
2	47 M	Tumor of brain.....	3.0	2.7	2.2	1.5	0.9	0.4	0.2	0.05
3	57 M	Carcinoma of stomach.....	4.0	3.1	4.0	2.0	1.1	0.8	0.2	0.1
4	47 M	Carcinoma of nose.....	4.1	2.8	3.1	2.2	1.4	0.6	0.3	0.08
5	67 F	Tumor of brain.....	3.8	2.4	2.6	1.2	1.0	0.8	0.2	0.1
6	21 F	Dermatomyositis .....	3.9	2.6	2.8	1.4	1.1	0.5	0.3	0.1
7	54 F	Coronary thrombosis.....	3.8	3.0	3.1	2.0	1.2	0.6	0.2	0.07
8	31 F	Pyelonephritis.....	2.1	1.4	1.6	1.1	0.8	0.3	0.1	0.05
9	43 M	Tumor of cord.....	4.8	3.6	3.2	2.0	1.0	0.5	0.2	0.1
10	50 M	Syphilis of central nervous system.....	4.6	3.0	3.4	2.0	1.0	0.5	0.1	0.05

by two rows of afferent ducts. The parietal sacculi can be traced throughout the course of the duct as far out as those measuring 0.1 mm. in diameter.

*Cholelithiasis.*—Eight specimens were from cases in which the presence of stones in the gall-bladder was revealed only at necropsy. In all cases careful clinical examination had failed to elicit any symptoms which would lead one to suspect that stones had passed down the common duct, so that the effect of stones in the common duct may be excluded. In seven of these cases the ducts had evidently dilated slightly, but throughout the whole system. Thus in this condition the diameter of the common hepatic duct varied from 6.5 to 11.5 mm., of the right hepatic from 3 to 8 mm., of the left

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hepatic from 3.5 to 7 mm., of the first order of branches from 3.5 to 5 mm., of the second from 1.7 to 3 mm., of the third from 0.7 to 1.5 mm., of the fourth from 0.2 to 0.5 mm., and of the fifth from 0.05 to 0.2 mm. (Table II.) Comparing these with the figures obtained from the normal specimens, it will be seen that the increase is fairly uniform throughout, although greatest in the extrahepatic duct. This increase in size gradually diminishes toward the periphery and is not confined to any one set of branches. In Case 2, no dilatation of the ducts occurred and the cast was of an absolutely



FIG. 3.—Biliary tree of a liver in which the gall-bladder was reduced to a fibrous sac. The gradual increase in size of the intrahepatic ducts is shown.

normal biliary tree. Examination of the gall-bladders in this series brought to light some interesting facts. The gall-bladder in Case 2 contained three small stones, but to all appearances was normal, showing no inflammatory thickening, adhesions, or dilatation. The organ must have preserved at least some measure of function. In Cases 12 and 13 the condition was similar, although evidence of chronic cholecystitis was more obvious. In Cases 14, 15, 16, 17 and 18 the gall-bladders were filled with stones and showed extensive thickening and fibrosis of the walls, and in Cases 17 and 18 the gall-bladders were reduced to fibrous sacs and were certainly functionless. Case 17 (Fig. 3) is typical of the group. The specimens in this group show that apparently there is some direct relation between the amount of dilatation of the ducts and the pathologic change in the wall of the gall-bladder.

*Cholecystectomy.*—Cases in which cholecystectomy has been performed were unsatisfactory, and give few data on the effect of the entire absence of the gall-bladder on the biliary passages. In the three cases in this series death occurred eight, nine and ten days following cholecystectomy which was performed because the gall-bladder was entirely functionless. In none, therefore, can any changes be attributed to extirpation of the gall-bladder at operation. In these cases dilatation of the ducts was similar to that observed

in the previous series, but was most marked in Case 21 (Fig. 4) in which stones were found in the common duct. In Case 19 dilatation was slight and a diameter of only 5.1 mm. was attained in the common hepatic duct. At operation an internal fistula was discovered between the gall-bladder and the

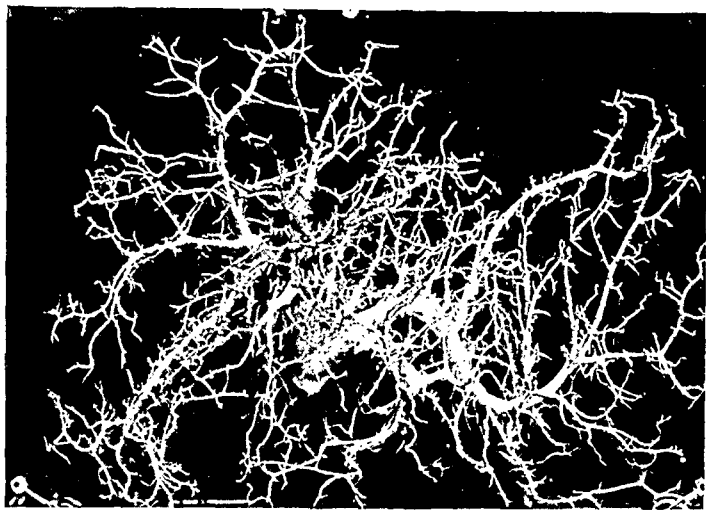


FIG. 4.—Biliary tree in a case of obstruction of the common duct resulting from intermittent attacks of colic.

transverse colon which provided for drainage of the biliary system; this serves as an explanation of the absence of dilatation of the biliary ducts.

far greater dilatation. Technical difficulties were encountered in introducing cannulas into ducts, which were frequently found to be a mass of scar tissue at the hilum of the liver, or were disorganized by previous operations; this was especially true in cases of benign lesion. In four cases marked chronic cholangitis had been established, while in one the process was acute and multiple abscesses had formed.

The variation in diameter in the hepatic ducts lay between 10 and 30 mm., the right and left hepatic ducts being from 7.5 to 16 mm., and from 8 to 30 mm., respectively. The extent to which the process had been carried was indicated by the dilatation of the branches; the diameter varied from 4.8 to 13 mm. for the first order, from 3.5 to 8 mm. for

the second, from 1.4 to 6 mm. for the third, from 0.2 to 1 mm. for the fourth, and from 0.1 to 0.2 mm. for the fifth. The longer and more complete the obstruction, the greater was the dilatation and the further its extent. Between the third and fourth orders of branches, however, a rapid transition

the common duct following cholecystectomy one year previously. Beginning sacculation.

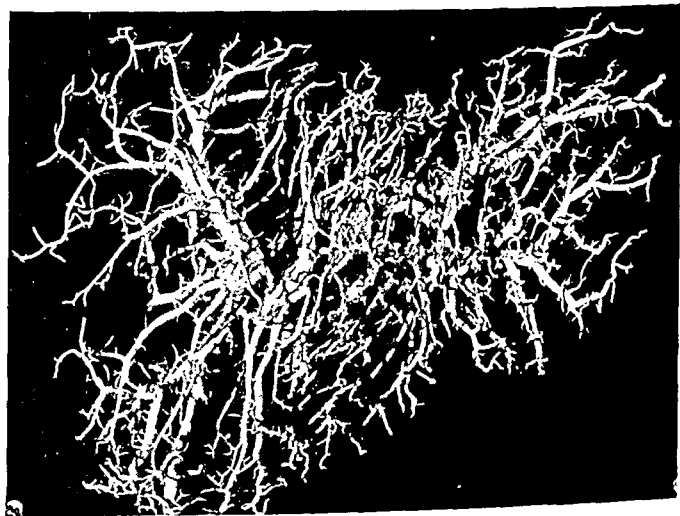


FIG. 5.—Biliary tree in a case of incomplete benign stricture of the common duct following cholecystectomy one year previously. Beginning sacculation.

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occurred so that the fifth branching appeared as a terminal filament attached to the stubby dilated duct.

Figure 5 (Case 22) shows the result of a benign fibrous partial stricture following cholecystectomy performed one year before. It may be noted that a much greater degree of dilatation exists here than in specimens of either of the two preceding groups. There is a more abrupt change from the finest terminal ducts to the widely dilated channels of the main trunks, which show beginning sacculation of their walls. Figures 6 and 7 (Cases 23 and 24, respectively) show the biliary trees in two cases

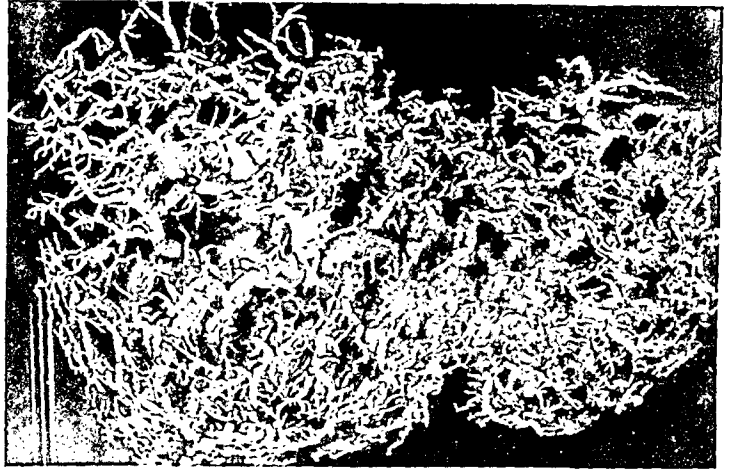


FIG. 6.—Biliary tree in a case of complete obstruction of the common duct of six weeks' duration. The terminal filaments on the tips of dilated and tortuous main trunks are shown.

of complete malignant stricture, the first (Case 23) of six weeks' and the second (Case 24) of eight weeks' duration. In both, sacculation and varicosity of the ducts is extreme, with well-marked clubbing and stubbiness of the branches of the third and fourth orders giving place to the small terminal

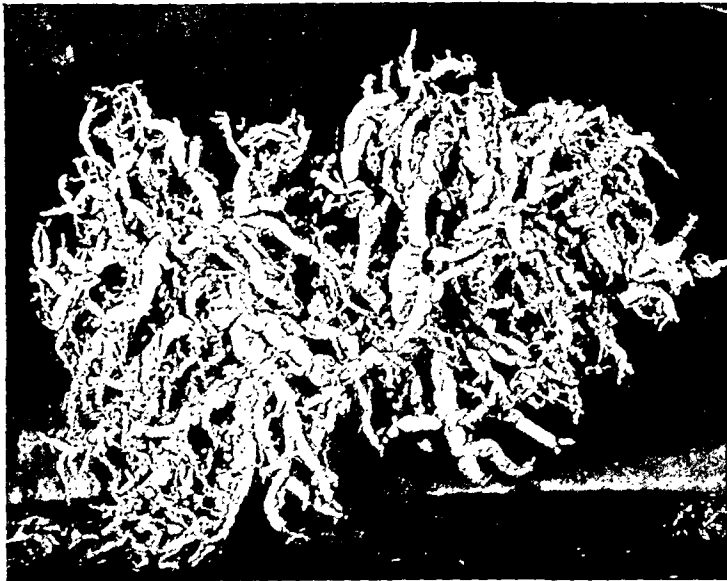


FIG. 7.—Biliary tree in a case of complete obstruction of the common duct of eight weeks' duration; marked clubbing and sacculation of main bile trunks.

fifth branches. It is also obvious that as the walls become thin and stretched they become smooth and lose their parietal sacculi. Nearer the hilum of the liver the main trunks lie close together entirely dwarfing the portal vein and indeed, as shown by a simultaneous injection of the ducts and vein in Case 25, causing stenosis and atrophy of many of its smaller branches, with parenchymal atrophy of the

areas supplied. Figures 8 and 9 (Case 26) show superior and inferior views of the biliary tree in a case of malignant stricture of the common duct of ten weeks' duration. Death was caused by acute cholangitis with multiple abscesses, which are represented by the many small nodules attached to the

ducts. The condition is comparable only to hydronephrosis, and in its effect on the parenchyma of the liver is entirely similar, to the effect of hydronephrosis on the renal tissue. A comparison between Figure 2 and Figure 9

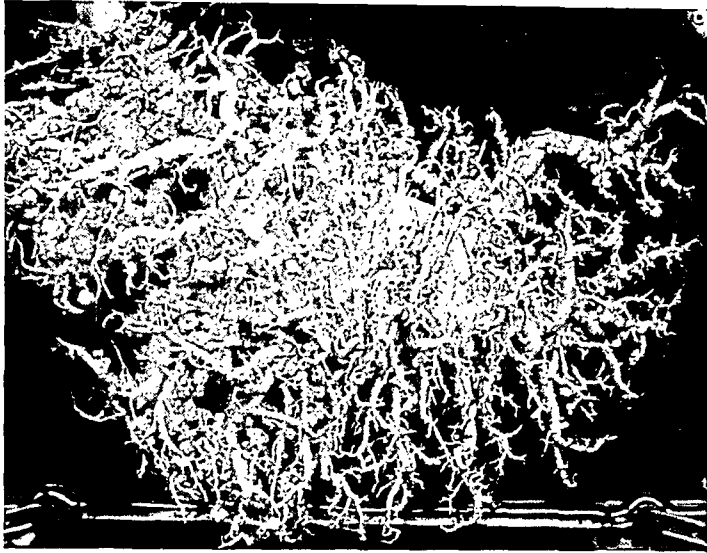


FIG. 8.—Biliary tree (superior view) in a case of complete obstruction of the common duct of ten weeks' duration, with marked suppurative cholangitis. Small abscesses attached to small bile ducts are shown.

is striking, the average diameter of the common hepatic duct in the latter being 30 mm. and of the branches of the third order 6 mm.

*The Effect of Obstruction of the Common Duct on the Portal Blood Supply.*—Rous and Larimore have recently demonstrated the importance of the portal blood to the maintenance of the liver. They found that occlusion of any local branch of the portal supply produced local atrophy of the parenchyma supplied by the obstructed branch, and compensatory hypertrophy at a distant point. Toldt and Zuckerkandl, in 1876 demonstrated that the normal liver undergoes notable changes in shape from birth to adult life; that some portions of the organ atrophy and others hypertrophy. The atrophy which they observed appeared to be identical with that after portal diversion. They attributed those changes, however, to pressure from surrounding organs. On the other hand, Rous and Larimore believe that the changes result from local alterations in the portal stream, due to transmitted pressure on the surface of the liver.

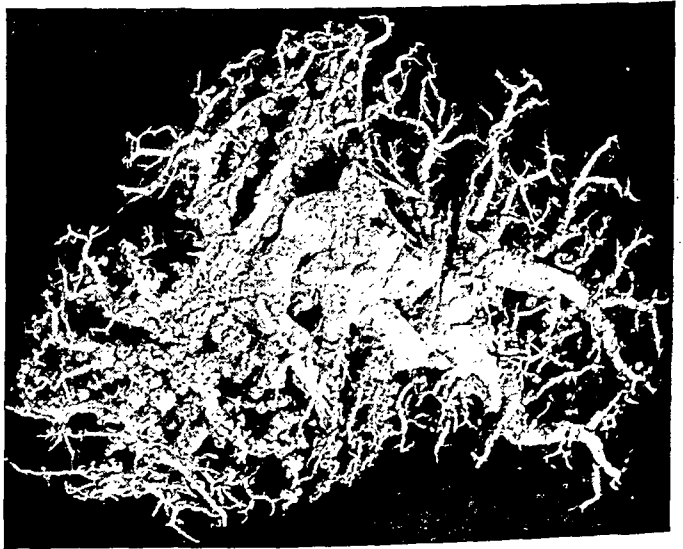


FIG. 9.—Same case as shown in Fig. 8. Inferior view. Note remarkable size attained by the main bile trunks.

Portal diversion frequently, if not always, occurs in cases of marked dilatation of the bile-ducts. The left hepatic duct is longer and more slender and comes off at a more acute angle than the right. Normally the bile-duct winds around the portal

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vein. (Fig. 10.) As the bile-ducts dilate, small and sometimes large branches of the portal vein are strangulated, with resulting partial obstruction of the portal vein. In Figure 11, the dilatation of the ducts of the third, fourth, and fifth orders with strangulation of the accompanying portal radicles is depicted. Figure 11 shows marked interference with the main portal blood supply at the hilum by the large dilated and sacculated hepatic bile-ducts. This is in accordance with the well-known pathologic observation of atrophy of the left lobe in obstructive lesions of the common bile-duct and demonstrates the mode of its development.

In most of the cases dilatation was more marked and extended farther in the left lobe than in the right. It is probable that a greater degree of dilatation results from the loss of the protecting hepatic parenchyma. This theory is in accord with the recent experimental work of Hinman and Hepler which showed that a greater degree of hydronephrosis occurred when partial ligation of the renal artery was performed in addition to ligation of the ureter, than when the ureter alone was ligated.

*Parietal Sacculi and Vasa Aberrantia.*—The parietal sacculi and vasa aberrantia were studied. In



FIG. 10.—Small bile duct winding around the portal vein. Normal relation.

normal biliary trees the parietal sacculi are not particularly prominent features on cursory examination, but on closer examination are seen as small sacculations appearing in two rows, one on either side of the duct. (Fig. 12.) They become smaller in the fourth and fifth orders of branches. The vasa aberrantia, on the other hand, extend beyond the wall of the duct and anastomose frequently. They often project from the parietal sacculi as well as from the wall of the duct itself and appear as curling thread-like structures. They are prominent in the angle between the right and left hepatic ducts but decrease in size along the smaller bile-ducts.

In case disease had destroyed the wall of the gall-bladder, the bile-ducts showed more generalized dilatation. The parietal sacculi and vasa aberrantia were not increased in size or in number. (Fig. 13.) In the case of cholecholelithiasis (Fig. 4) the main bile-ducts were markedly dilated. (Case 21, Table II.) In this case parietal sacculi were entirely absent but appeared along the branches of the fourth and fifth orders. The vasa aberrantia, on the other hand, were somewhat elongated and enlarged and more prominent between the right and left hepatic ducts. They gradually decreased in size until at the fourth order of branches they again appeared normal.

Very little can be said of the results following cholecystectomy, since

TABLE II.  
*Dimensions of Biliary Trees in Cases of Cholelithiasis and Following Cholecystectomy.*

Diameter of ducts, mm.														
Case	Age, sex	Diagnosis	History of biliary disease	Condition of gall-bladder	Obstruction of common duct	Hepatic			Successive branches in descending order					
						Common	Left	Right	First	Second	Third	Fourth	Fifth	
1	53 F	Fibromyoma; hysterectomy	Indigestion five years	Three stones; partial function		4.0	3.0	3.5	2.0	1.1	0.9	0.5	0.1	
2	51 F	Myocardial degeneration		Multiple stones; functionless (?)		6.5	3.5	3.0	2.4	2.5	1.0	0.4	0.1	
3	69 F	Cerebral hemorrhage		One large stone; partial function (?)		6.7	6.0	4.9	2.8	1.7	0.7	0.2	0.1	
4	54 F	Carcinoma of ovaries		Multiple stones; functionless		7.5	3.8	3.2	2.4	2.7	1.0	0.5	0.2	
5	68 M	Myocardial degeneration		Multiple stones; functionless		8.0	5.1	5.0	3.2	2.1	1.0	0.4	0.05	
6	54 M	Abscess of lung		Multiple stones; functionless		10.0	4.0	5.0	2.5	2.0	1.0	0.4	0.1	
7	65 M	Rectal polyposis; peritonitis		Multiple stones; functionless		10.0	7.0	8.0	5.0	3.0	1.5	0.5	0.1	
8	56 F	Hyperthyroidism		Multiple stones; functionless		11.5	6.0	7.0	4.0	3.0	1.5	0.5	0.1	
9	45 M	Cholecystitis; cholecystectomy	Nausea; vomiting; recurring colic in right upper quadrant for twelve years	Excised nine days before; internal fistula; multiple stones		5.1	3.8	4.0	2.0	1.5	0.7	0.2	0.1	
10	40 F	Cholecystitis; cholecystectomy	Nausea; distress in right upper quadrant for one year	Excised eight days before; multiple stones		7.1	5.3	5.4	3.9	2.1	1.2	0.7	0.1	
11*	62 F	Cholelithiasis; cholecystectomy	Two attacks of jaundice; colic for thirty years	Excised ten days before; contracted and fibrous	Stones	9.0	8.0	7.5	4.8	3.5	1.4	0.2	0.1	

\* Stones obstructed common duct.



## EFFECTS OF OBSTRUCTION OF THE BILE DUCTS

in each of the cases examined, cholecystectomy had only recently been performed for cholecystitis and stones. There was no apparent change in the parietal sacculi and vasa aberrantia, so that they resembled those seen in the normal biliary tree and in the system in which the gall-bladder was functionless.

In the case of benign incomplete stricture and in the four cases of complete malignant stricture of the common duct, the entire biliary trees were tremendously dilated. This process was more marked the longer the duration

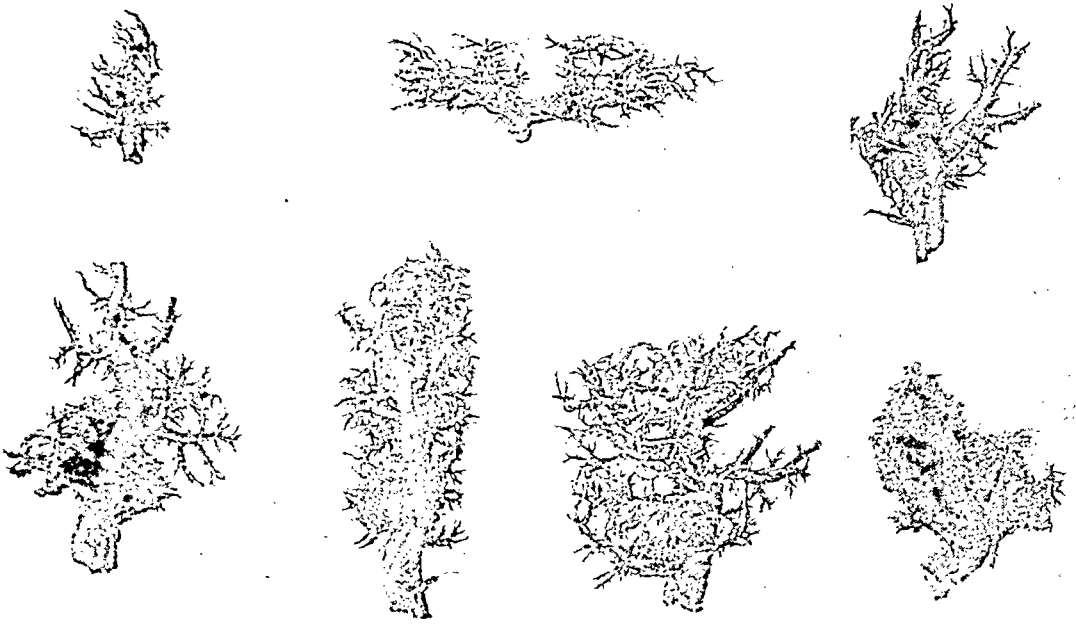


FIG. 11.—Serial view showing strangulation of small portal radicles by dilating bile ducts near the periphery of the liver.

of the obstruction. In all five instances the parietal sacculi had completely disappeared, the wall of the duct appearing smooth. The vasa aberrantia were usually found to be enlarged, curled and somewhat sacculated. In a few instances they were flattened out along the wall of the duct while in others they were so large as to resemble bile-ducts. The abrupt termination of a small branch in a curled, thread-like structure is characteristic of the vasa aberrantia. In the case of malignant stricture of ten weeks' duration their orifices were enormously enlarged and seemed to be in the process of being included by the wall of the dilating duct.

The manner of dilatation of these structures resembles that of the biliary tree, that is the dilatation ceases abruptly near the ends of the ducts, giving one the impression that the factors which produce the enlargement of the biliary tree, also produce the dilatation of the vasa aberrantia and the inclusion of the parietal sacculi.

*Discussion.*—Until quite recently dilatation of the bile-ducts was considered to be one of the secondary affections of the liver. Nevertheless it is certain that it can assume an importance of the first magnitude. Weber was

perhaps the first to emphasize the relationship between this condition and hydronephrosis and to point out the similarity in the associated lesions. In both conditions, and indeed in conditions of obstruction of the ducts of all secreting glands, secretory stasis, dilatation of ducts, vascular disturbances



FIG. 12.—Branch of a normal biliary tree. The parietal sacculi appear as two lateral rows slightly raised from the surface of the duct. The vasa aberrantia are seen as twisted thread-like structures.

from collateral pressure, sclerosis and parenchymatous atrophy are common. The process is more marked in the case of the kidney because the secretory pressure is so much higher. Moreover the slighter degrees of hydronephrosis are more apparent not only on account of the extraparenchymatous situation of the pelvis but by reason of the greater ratio of duct to secreting tissue. Nevertheless, despite the fact that dilatation of the bile-ducts rarely becomes obvious from the exterior, unless it be in the extrahepatic ducts or around the edge of the left lobe, the upset in internal economy is often no less profound.

A brief review of the various grades and types of dilatation of the bile-ducts is desirable. In the group of cases of cholelithiasis, dilatation was mild in seven cases and absent in one. Little except this slight

generalized increase in diameter served to distinguish the ducts from the normal, although the change was if anything rather more marked in the extrahepatic ducts. The diminution in diameter was gradual and not confined to any one order of branching. In Case 10, no dilatation occurred and the gall-bladder was apparently in good condition even though it contained three

## EFFECTS OF OBSTRUCTION OF THE BILE DUCTS

TABLE III.  
*Dimensions of Biliary Trees in Cases of Partial and Complete Stricture of the Common Duct.*

Case	Age, sex	Diagnosis	History of biliary disease	Condition of gall-bladder	Obstruction of common duct	Diameter of ducts, mm.							
						Hepatic		Successive branches in descending order					
						Common	Left	Right	First	Second	Third	Fourth	Fifth
1	46 F	Benign stricture of common duct	Cholecystectomy one year previously; jaundice six months	Excised one year before; multiple stones	Partial	10.0	7.5	8.0	5.5	3.7	1.6	0.75	0.1
2	68 F	Carcinoma of bile ducts	Intermittent jaundice six months; attacks of colic in right upper quadrant	Excised six days before; choledochostomy; multiple stones	Complete for six weeks	14.0	10.5	11.0	7.5	6.0	4.0	1.0	0.1
3	76 M	Carcinoma of pancreas	Painless jaundice for eight weeks	Distended	Complete for eight weeks	18.0	12.0	13.0	10.0	6.0	3.0	0.5	0.1
4	71 M	Carcinoma of pancreas	Painless jaundice for seven weeks	Distended	Complete for seven weeks	22.5	13.5	13.0	11.0	10.5	5.6	1.6	0.2
5	55 F	Carcinoma of pancreas	Increasing jaundice for ten weeks; attacks of colic in right upper quadrant	Distended	Complete for ten weeks	30.0	20.0	16.0	13.0	8.0	6.0	1.0	0.1

small stones. The amount of dilatation of the ducts in the other seven cases was directly proportional to the amount of injury to the wall of the gall-bladder, being greatest when that organ had been reduced to a fibrous sac. This is in accord with the views of Judd, who finds clinically, that in every case of cholelithiasis in which the gall-bladder is extensively diseased, there is a noticeable dilatation of the extrahepatic ducts. In the cases in which



FIG. 13.—Vasa aberrantia appearing as an anastomosing network between the right and left hepatic ducts and along the walls of the smaller ducts. The parietal sacculi are represented by the rows of knob-like elevations along the sides of the ducts.

cholecystectomy had been performed, dilatation of the bile-ducts also occurred but was least marked when a fistula had been established between the gall-bladder and the transverse colon. It seems that in this case the drainage either prevented dilatation or caused a return of dilated ducts to normal size by relieving intraductal pressure.

In contradistinction to this mild form of dilatation, the gradual partial, or complete occlusion of the ducts from stricture produces a most remarkable picture. There is a tremendous increase in the diameter of the ducts with stretching and thinning of the walls and

consequent obliteration of the pits which form a prominent feature of the normal duct. The process extends more or less uniformly through consecutive branches as far as the fourth and fifth orders. Here there is an abrupt transition from dilated to narrow ducts, the actual site of the change depending on the duration and degree of obstruction. The greater the obstruction the farther out does this transition take place, and the more marked the appearance of stubbiness and clubbing of the smaller branches.

The sphincter of Oddi is the mechanism controlling the flow of bile into the duodenum. The normal intraductal pressure has been variously estimated as from 60 to 70 mm. of bile and the normal tonus of the sphincter as from 60 to 300 mm. Judd and Mann have shown that normally following chole-

## EFFECTS OF OBSTRUCTION OF THE BILE DUCTS

cystectomy the extrahepatic ducts dilate, but that dilatation is prevented by section of the sphincter of Oddi. Rost finds that dilatation fails when the tonus of the sphincter is low. Bollman, Mann and Depage have shown that cholecystitis, produced experimentally by a specific organism, abolishes the concentrating activity of the gall-bladder, while Potter and Mann have demonstrated that cholecystectomy following such an infection causes a marked rise in pressure in the common duct.

It seems, therefore, that the loss of "safety valve" action of the gall-bladder, either by disease or removal of the organ produces generalized dilatation of the ducts, due to the rise in intraductal pressure against the tonic sphincter. These observations confirm and extend the previous experiments of Judd and Mann, and also tend to show that the amount of dilatation is directly proportional to the degree of pathologic change in the wall of the gall-bladder.

The question of portal diversion is interesting and has been the subject of considerable experimental investigation. Rous and Larimore, as previously stated, have definitely shown that when one branch of the portal vein is ligated there follows compensatory hypertrophy of hepatic parenchyma which is supplied by the unobstructed portion of the vein; also that atrophy of hepatic parenchyma occurs in the areas supplied by the obstructed branch of the portal vein. That this condition actually occurs during the process of disease of the biliary tract is certain. (Figs. 10, 11 and 12.) It is explained by the fact that the portal vein normally winds around the bile duct (Fig. 10) and obstruction occurs when the bile-duct dilates to any appreciable extent. Atrophy follows and permits greater dilatation of the bile-ducts, because the supporting parenchyma has been destroyed. By virtue of the position and course of the left branch of the portal vein and left hepatic bile-duct, portal diversion and parenchymal atrophy usually occur earliest here with consequent greater dilatation of the bile-ducts.

An analogy between this condition and hydronephrosis has been drawn by Hinman and Hepler. The greater degree of hydronephrosis which follows partial ligation of the renal artery, together with ligation of the ureter, can be explained on the same basis.

From this investigation it would seem that the parietal sacculi and vasa aberrantia are functionless structures. They are both present under normal conditions. The parietal sacculi disappear from the walls of dilating ducts, while the vasa aberrantia become enlarged and sacculated, and appear as curling, anastomosing structures on opposite sides of the ducts. The extent to which the parietal sacculi disappear and the amount of dilatation of the vasa aberrantia seem to be directly dependent on the intraductal pressure. This theory is further substantiated by the fact that the parietal sacculi, which are located within the wall of the duct, disappear while the vasa aberrantia, which project beyond the duct, become enlarged. It would seem therefore that these structures are altered in shape and size as a result of the increase in intraductal pressure rather than from any functional hyper-

trophy. They can not then be considered as little gall-bladders attached to the walls of the ducts but simply as vestigial remnants of previously functioning structures.

## SUMMARY AND CONCLUSION

The biliary trees of twenty-six livers were examined by the celloidin-injection and corrosion method. In ten normal livers, the internal diameter of the common hepatic ducts did not exceed 5 mm., and the diameter of the succeeding branches diminished to 0.05 mm. in the fifth order. Of eight livers in which the gall-bladders contained unsuspected stones, general enlargement of the ducts was found in seven, the diameter of the dilated common hepatic ducts being between 6.5 and 11.5 mm. The dilatation was slightly greater when the injury to the gall-bladder was more severe. In the case in which there was no dilatation the gall-bladder contained three small stones but was otherwise apparently normal. In three cases in which cholecystectomy had been performed, eight, nine, and ten days previous to death, dilatation of the biliary ducts occurred, but was least in a case in which there was an internal fistula between the gall-bladder and colon. In five cases in which benign or malignant strictures of the common duct existed, the amount of dilatation was great and the diameter of the common hepatic duct varying from 10 to 30 mm. The process extended throughout the whole biliary tree, grossly as far as the fifth order of branches. The more complete the obstruction and the longer its duration, the farther the extreme change occurred and the more abrupt was the transition from dilated branches to terminal filaments.

Portal diversion occurred following marked dilatation of the bile-ducts and was associated with atrophy of the hepatic parenchyma in the areas supplied by the obstructed portal branches. This process was accompanied by compensatory hypertrophy in other regions. Dilatation of the bile-ducts was greater in the regions of marked parenchymal atrophy since the supporting tissue tended to prevent over-distention of the ducts.

The parietal sacculi and vasa aberrantia were studied in this series of cases. In normal biliary trees the parietal sacculi were seen as small sacculations appearing in two rows on opposite sides of the ducts decreasing in size as the ducts diminished in calibre. They were not found to be increased in size or number in cases in which the gall-bladder was diseased or had been removed. In cases of choledocholithiasis and benign malignant stricture they were absent.

The vasa aberrantia were seen extending beyond the wall of the duct and anastomosing with each other frequently. They often projected from the parietal sacculi as well as from the wall of the duct itself, appearing as curling thread-like structures. They were more prominent between the right and left hepatic ducts, but were present along all ducts. These structures, like the parietal sacculi, were unchanged in size and number following extensive disease of the gall-bladder and cholecystectomy. In cases of chole-

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docholithiasis and benign and malignant strictures they were tremendously enlarged and sacculated, corresponding in degree to the amount of dilatation of the duct.

The parietal sacculi appeared to be absorbed by the wall of the dilating duct while the vasa aberrantia were enlarged as a result of the increase in the intraductal pressure, proportionate to the amount of dilatation of the ducts themselves.

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# GASTROJEJUNAL ULCERS AND GASTROJEJUNOCOLIC FISTULÆ

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FROM THE SURGICAL AND GASTRO-ENTEROLOGICAL DEPARTMENTS OF THE LAHEY CLINIC

SINCE Braun reported the first case of gastrojejunal ulcer in 1899, there have been a constantly increasing number of such reports, until to-day the total approaches 1000. The increase is apparently in direct proportion to the growing popularity of gastro-enterostomy as a surgical procedure in cases of gastric and duodenal ulcers.

The last five years are marked by controversial discussion, notably with respect to the relative merits of gastro-enterostomy and partial gastrectomy, and the gastrojejunal ulcer is used as the *pièce de combat*,—those favoring gastro-enterostomy holding that its incidence is so slight as to be quite outweighed by the advantages in the larger percentage of cases; and those who advocate partial gastrectomy arguing that the incidence of gastrojejunal ulcer is actually much greater than is conceded by the exponents of gastro-enterostomy, and that, in any event, it is so unfortunate a lesion and so difficult of treatment (with high tendency to recurrence) that any procedure which may cause it should be avoided.

It has therefore interested us to review its incidence, its causes, and, if possible, means of avoiding such an unfortunate sequela.

Paterson, who wrote an exhaustive article on the subject in 1909, estimated "the probable risk of jejunal ulcer following gastrojejunostomy as under 2 per cent." He collected 52 certain and 10 doubtful cases (including 3 of his own) on record up to 1909, and gives abstracts of the same. Although certain authors of wide experience still report an incidence under 2 per cent., the average incidence as reported in American literature (excluding Lewisohn) is higher—2 to 5 per cent., and in German literature, 5 to 10 per cent. (see Table I).<sup>\*</sup> Lewisohn estimates that the actual incidence is 34 per cent., but this figure has been disputed by many eminent surgeons. Only 3 cases had been reported from America prior to 1909, and Paterson found that leading surgeons at that time, such as John B. Murphy and the Mayo brothers, had not met with a single case, although they were performing about 75 gastrojejunostomies annually. This is, of course, no longer true. Mayo-Robson reported the first case in English literature, in 1904. Because the incidence is in so many instances published in percentages, often without indication of the total number of cases in the series, to estimate the actual number of reported cases to date seems to us impossible. It should

<sup>\*</sup> It is not claimed that this table is exhaustive, merely representative.

further be remembered that many cases never find their way into the literature. It is interesting, however, that Ssokolov, a Russian surgeon, states in 1925 that the 126 cases which he worked up from the Russian literature constitute one-seventh of those reported in the world up to that date. This would make the total incidence 882, which we believe might very fairly be raised to 1000.

TABLE I

*Incidence of Gastrojejunal Ulcer Following Gastro-enterostomy (All Types).*

Author	Incidence
Paterson	3 cases in 348 (also 59 collected cases)
Gosset	79 cases
Deaver	2 per cent.
Mayo, C. H., and Rankin	1 to 3 per cent.
Balfour (1925)	About 2 per cent.
Balfour (1926)	139 cases in 8600. 1.37 per cent. following duodenal ulcer; 0.07 per cent. following gastric ulcer; has seen total of 270 ulcers, 131 gastro-enterostomies performed elsewhere
Judd, E. S.	1.04 per cent. in series of 3324
Moynihan (1920)	4 in 694
Horsley	4 per cent.
Roeder	Not over 5 per cent.
Strauss, A. A. (1925)	20 to 30 per cent.
Lewisohn	34 per cent. (23 in 68 cases); 18 per cent. proved by operation; 16 per cent. diagnosed clinically by X-ray
Pauchet	5 per cent. following gastro-enterostomy alone
Henry	1 case
Ashcroft, A. T.	2 cases
Brickner and Milch	0 per cent. (give careful attention to technic of gastro-enterostomy and to post-operative diet)
Neuhof	1 case
Takats (Budapest)	21 in 626 operations (charity clinic; unable to regulate post-operative diet)
Walton	1.4 per cent. (in 783 cases); 1.7 per cent. after simple gastro-enterostomy
Chiari	11 cases
Pfeiffer and Smith	1 case
Rowlands	1.5 per cent.
MacGuire	2 cases
Barber	1 case
Moschcowitz	"Rare", although he performs many gastro-enterostomies
Erdmann and Carter	"Variously reported from different surgeons as 2 to 10 per cent."
Peck	2 to 5 per cent.
Woolsey	Less than 2 per cent.
Koennecke and Jungermann (Goettinger Clinic)	4 per cent. in series of 520
Renton	3 cases
Finsterer	29 cases (following von Haberer operation)

# GASTROJEJUNAL ULCERS AND GASTROJEJUNOCOLIC FISTULÆ

TABLE I—*Continued*

Author	Incidence
Szemoe	1 case
Denk	1 case
Jenckel and Schueppel	7 cases
Mikulicz	2 in 160 cases
Schostak	1 in 92 cases
Rotgaus	1 in 49 cases
Wickenhauser	3 in 115 cases
Moore and Marquis (Mayo Clinic)	2.3 per cent. in 200 cases
Ssokolov, S. (review of Russian surgery)	126 cases (reports "world incidence" to 1925 as 1 to 1.5 per cent.)
Sherren	29 cases in 903; 2 cases in 276 (operated on more than two years ago)
Lahey Clinic	16 cases in 340 cases of peptic ulcer

*Age and Sex.*—Gastrojejunal ulcer occurs much more frequently following duodenal ulcers than gastric, and is comparatively rare in women. Paterson placed the sex incidence at 78 per cent. male. In Balfour's series of 270 cases, only 22 were women; 19 of Walton's 20 cases were men. Fourteen of our 16 cases were in men.

The average age is between thirty and forty, though one case has been observed in a child of two months, operated on for pyloric stenosis, and another in a man over sixty years of age. Michaelson, of Stockholm, reports two cases after gastro-enterostomy in girls aged fourteen and eighteen.

*Pathology.*—Gastrojejunal ulcers are usually single, although they may be multiple; and are usually smaller than the ordinary peptic ulcer. They are usually situated on the suture line, or on the anterior surface of the jejunum close to the anastomosis, often directly opposite the opening into the stomach. They may, however, be intragastric (Erdmann and Carter),  $\frac{1}{4}$  to  $\frac{3}{4}$  inch from the anastomotic area. Either the efferent or afferent loops may be the site, but more commonly the efferent.

Walton calls attention to the fact that even when the ulcer is at some distance from the anastomosis, there is always evidence that it started directly at the junction—a scar extending to the anastomotic line.

The ulceration may be acute with soft walls and a tendency to perforation, or it may be indurated with surrounding adhesions. By far the most common type of gastrojejunal ulcer is the penetrating ulcer. Perforation may lead to abscess formation, and the abscess may evacuate either anteriorly or posteriorly. Perforation into the colon produces a gastrocolic or gastrojejunocolic fistula in about 10 per cent. of cases.

The transverse colon may form the base of a crater, the ulcer having completely passed through the jejunal wall. (Jenckel and Schueppel report a case in which the ulcer had penetrated into the pancreas.)

*Perforation* is common. In 45 of Paterson's series of 62 collected cases,

there was perforation; Wright found 31 acute perforations in 135 cases, and Ssokolov reports that 25 per cent. of the cases he reviewed perforated.

Paterson gives an excellent classification of the types of perforation:

"Group 1.—Cases in which perforation into the general peritoneal cavity occurs.

"Group 2.—Cases in which, owing to the formation of localizing adhesions, perforation does not result in the escape of bowel contents into the general peritoneal cavity.

"(a) Cases in which the base of the ulcer becomes adherent to the abdominal parietes, so that perforation results in inflammatory exudation into the abdominal wall.

"(b) Cases in which the base of the ulcer becomes adherent to and perforates into a hollow viscus, the colon in the cases so far recorded."

None of our cases perforated into the free peritoneal cavity. Two had perforated into the transverse colon, showing gastrojejunal fistulae.

The greater number of cases fall into group 2, according to Ssokolov, particularly 2 (b).

*Recurrence.*—Aside from the tendency to perforation, gastrojejunal ulcers are quite likely to recur, as illustrated by numerous cases in the literature, in which three, four, and even six operations have been performed for recurrent ulcer, sometimes at very short intervals. In fact, in the cases which manifest this tendency to recurrence, the first gastrojejunal ulcer usually develops shortly after the original gastro-enterostomy, and the subsequent ulcers at correspondingly short intervals. This may point to an infective origin with failure to discover and remove the primary focus, or it may be used as an argument for the theory of "personal idiosyncrasy" or ulcer diathesis.

One of our cases had had a gastrojejunal ulcer following a gastro-enterostomy for duodenal ulcer with a later recurrence of another gastrojejunal ulcer following the excision and reconstruction of the gastro-enterostomy before coming to us, and at our operation showed a gastrojejunal ulcer at the stoma and a jejunal fistula in the proximal loop of the jejunum about two inches from the stoma, indicating that there had also been a jejunal ulcer there which was obliterated by the formation of the fistula.

In two of our patients gastro-enterostomy was done originally by us for duodenal ulcer. In one case the ulcer was also excised with the cautery and in the other nothing was done to the ulcer itself. In both cases the gastro-enterostomy was taken down, the gastrojejunal ulcer being removed with it, and the alimentary canal restored to its original course. In both cases duodenal ulcers have apparently recurred.

*Etiology.*—The etiology of gastrojejunal ulcers is still in a state of hypothesis. The supposed causes which find the largest number of supporters are (1) sudden exposure of the jejunum to hyperacid gastric contents; (2) the use of unabsorbable sutures and Murphy buttons (now rare); (3) operative trauma to the mucosa, by use of heavy clamps, etc.; (4) infection. Many surgeons believe that certain individuals have a personal idiosyncrasy or familial tendency to ulcer. Erdmann and Carter cite one case with seven operations for marginal ulcer, although all trauma and

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foci of infection were eliminated, which seems to point to idiosyncrasy. Hoguet and Cole, however, remark that "idiosyncrasy" probably means reinfection at a new site from an undiscovered primary focus.

Other factors mentioned in the literature as contributing to the development of this unfortunate sequela to gastro-enterostomy are: (1) carelessness in post-operative diet and post-operative medical supervision; (2) the same causes which produced the original ulcer; (3) type of operation used (particularly frequent after von Eiselsberg pyloric exclusion); (4) breaking down of hæmatomas; (5) local irritations; (6) syphilis; (7) chemical changes; (8) faulty operative technic, particularly the placing of the anastomosis too high (Woolsey); (9) racial tendency to ulcer in the Hebrew (Eustermann); (10) excessive smoking, alcoholism, and excessive use of condiments; (11) fatigue and exposure; (12) too small an opening of the anastomosis (Pfeiffer and Smyth); (13) inclusion in the gastro-enterostomy of part of the inflamed gastric wall; (14) retrograde invagination of the jejunum into the stomach (Blond); (15) circulatory interference in the attached jejunum, due to tension, arteriosclerosis, or injury to the mucous membrane, either at the time of operation, or later, by hard particles of food (Tiegel); and (16) circular spasms of the gastric and duodenal musculature (Blond).

This multiplicity of hypotheses indicates the complexity of the problem with which we are dealing, and emphasizes the fact that the etiology of these ulcers is really unknown.

*Primary ulcer of the jejunum* is so rare that little light can be thrown on the subject from this angle.

Von Roozer, who first suggested the possibility of primary ulceration of the jejunum (1909), called attention to the fact that unless there has been artificial anastomosis, the jejunum is remarkably free from ulceration. Richardson, in 1922, collected twelve cases from the literature and added two of his own. Since then Fischer has reported another case. Of Richardson's 12 cases, 9 occurred between the ages of forty-five and sixty-three, and 10 were in men. Perforation occurred ten times in the 12 cases. In 5 cases which came to autopsy, the jejunal ulcer was the only one present in the intestinal tract. In 6 cases confirmed by autopsy or operation, the stomach and duodenum were negative; 2 cases showed a lesion of the duodenum or stomach; and in 4 cases, the condition of these organs was uncertain.

Richardson concludes, in discussing the etiology of these primary ulcers of the jejunum: "No definite etiology may be assigned to them. It is possible that in so rare a condition there may be almost as many causes as cases."

*Hyperacidity.*—That the sudden exposure of the jejunum to hyperacid gastric contents (to which it is unaccustomed under normal conditions) may lead to irritation of the mucosa with resultant ulceration is agreed by practically all authors.

Kocher is of the opinion that the acid gastric juice may stimulate circular contractions of the jejunum just below its junction with the stomach, with the formation of a kind of cul-de-sac in which the stay of the gastric juice may be prolonged and so cause ulceration.

Paterson says: "Jejunal ulcer following gastrojejunostomy is the result of a toxic agent or poison which so injures or kills the cells of the jejunal mucous membrane that

they are readily digested by the intestinal juice. The toxic agent usually present is free hydrochloric acid, but possibly other toxic substances may be present, and either may increase the effect of the other. Thus a small percentage of free hydrochloric acid in the jejunum, which by itself would not cause ulceration, may in the presence of some other toxic agent produce ulceration.

"The circumstances under which free hydrochloric acid may be present in the jejunum are (1) hyperacidity of the gastric contents so that the bile and pancreatic juice are unable to neutralize completely all the acid entering the jejunum; (2) normal percentage of hydrochloric acid in the gastric juice, but excessive secretion, so that the amount of hydrochloric acid discharged into the jejunum is greater than can be neutralized; (3) diversion of the course of the bile and pancreatic juice, so that part of the jejunum is exposed to the action of the gastric contents unmixed with bile and pancreatic juice, as after operations of the "Y" type, and gastrojejunostomy with entero-anastomosis; (4) normal acidity and amount of gastric secretion, but incomplete neutralization in the jejunum owing to temporary diminution of the flow of bile, and of the secretion of pancreatic juice."

Judd reports that in more than 60 per cent. of the cases of gastrojejunal ulcer seen at the Mayo Clinic, the acids were high, even after gastro-enterostomy.

Hoguet and Cole raise the question whether hyperacidity is essential to the development of secondary ulcer, or whether this condition exists only after the appearance of ulcer.

Balfour believes that the recurrence of ulcer is directly associated with failure to reduce the acidity, to maintain this reduction, and to provide adequate drainage; and that for these reasons the stoma should reach the lowest point of the greater curvature.

Advocates of partial gastrectomy rather than gastro-enterostomy as the initial procedure (Lewisohn, Strauss, and many German authors) claim that this insures anacidity and precludes the possibility of gastrojejunal ulcer. Ssokolov, however, states that gastrectomy does not prevent peptic ulcer of the jejunum, as it occurred in 4.32 of the cases in his series in which this operation was done.

Sherren points to the rarity of gastrojejunal ulcer in women, whose acidity is lower than that of men, as proof that hyperacidity has much to do with the occurrence of secondary ulcers.

Walton, in studying acidity before and after gastro-enterostomy, found it reduced in cases of gastric ulcer, but not as consistently in cases of pyloric or duodenal ulcer. This may account for the fact that the incidence of gastrojejunal ulcer is so much greater following operation for duodenal and pyloric ulcer. In Balfour's series of 139 cases, the original lesion was duodenal in 130.

Sherren has notes on pre- and post-operative test meals in 285 cases of chronic duodenal ulcer; 37 of these showed little or no reduction in gastric acidity, and in all of these some abnormality was noted (adhesion to the gall-bladder or liver, opening nearer the pylorus than usual, smaller than usual, ante-colic operation, or bruising around the anastomosis). Seventeen of the 37 have had further symptoms; 5, jejunal ulcers. In 131 cases free hydrochloric acid was absent and the total acidity low; none of these had return of symptoms. In 65 cases there was great reduction, but not abolition of free hydrochloric acid; these patients are all in excellent condition. In 52 cases the free hydrochloric acid was reduced to normal, 5 of these developed symptoms, but none had a jejunal ulcer. These data show a definite relationship between gastric acidity and secondary ulcer.

Douglas states that ulcers do occur with low acidity, and that he has had patients with high acidity who do not develop them.

MacGuire cites a case in which marginal ulcer developed after practically all of the acid-bearing portion of the stomach had been removed.

Lewisohn has reported a case in which the gastric contents were hypoacid.

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We have had two ulcers in the gastric stump after partial gastrectomy, one in a patient with low acid and one in a patient with no free hydrochloric acid.

The location of the marginal ulcer—usually close to the stoma, or in the stoma itself—favors the argument that the ulcer is due to the chemical irritation of the jejunum by gastric juice not neutralized by the alkaline duodenal contents.

*The use of unabsorbable sutures and of Murphy buttons* has been shown both clinically and experimentally to be a factor in the production of secondary ulcer, and has therefore been largely discarded. That they are not the sole factor is evident from the continual occurrence of ulcers in which only absorbable sutures have been used.

*Operative Trauma.*—The use of heavy clamps should be avoided, and the technic so carried out as to minimize trauma. More careful attention to suture material and to the details of operative technic has definitely diminished the incidence of secondary ulcers.

*Infection.*—Infection and hyperacidity, factors over which the surgeon has less control than of the strictly mechanical factors just discussed, remain the important ones. Deaver, Woolsey, Pfeiffer and Smyth, Balfour, Judd, and many others emphasize the necessity of removing all foci of infection at the time of the primary operation, if gastrojejunal ulcers are to be avoided. Particular attention should be directed to the gall-bladder and appendix, and certain authors (Deaver, Woolsey, Erdmann, Pfeiffer and Smyth) advocate cholecystectomy coincident with gastro-enterostomy if there is any indication that the gall-bladder is diseased. It is useless to remove the gastric or duodenal ulcer, and not remove its cause. To do so is merely to invite secondary ulceration.

*Type of Operation.*—It is difficult to determine just how much relation exists between the type of original operation and the development of marginal ulcers. The majority of writers agree that the incidence is greater following anterior than posterior gastro-enterostomy, and particularly high after the von Eiselberg exclusion.

Judd reports a case following sleeve resection; Hoguet and Cole, following the Polya operation. They believe that in this case an inflamed appendix and colon constricted by adhesions might have caused both the original and the secondary ulcer. We have one recurrence of a gastric ulcer directly on the suture line following midgastric sleeve resection for a large gastric ulcer.

Friedmann found that of 120 cases subjected to a Billroth I or II operation, 8 developed gastrojejunal ulcer. In these the resection was too small. Forty-three cases of gastrojejunal ulcer followed a von Eiselberg gastro-enterostomy, or the Riedel-Payr method, according to this author.

Ssokolov reports cases following both anterior and posterior gastro-enterostomy, also following Roux's method, and in one case following a Billroth II. He also states that gastrectomy does not prevent gastrojejunal ulcer, as the latter occurred in 4.32 per cent. of his cases in which this operation was done.

After von Eiselberg's unilateral exclusion of the pylorus, Ssokolov found the inci-

dence to be 20 per cent.; von Haberer reports it as 17 per cent. Denk, Takats, Carman, and Keppich likewise condemn it.

Ochsner stated in 1922 that in every case in which he had operated for jejunal ulcer, the anastomosis was not at the lowest point of the stomach, thus allowing an accumulation of acid or decomposing gastric contents, which corresponds to the condition which produced the original duodenal ulcer.

Peterson condemned the "Y" type of operation because, after this, the bile and pancreatic juice enter the jejunum some inches below the anastomosis, so that this and several inches of jejunal mucous membrane are exposed to the action of unneutralized gastric contents. Twenty-four per cent. of gastrojejunal ulcers followed this type of operation.

*Symptoms.*—Gastrojejunal ulcer, like gastric ulcer, may in certain cases run a symptomless course until sudden severe pain at the level of the umbilicus indicates the onset of perforation which, as we have stated, is not uncommon. The majority of cases, however, produce symptoms, and in these the onset is gradual and varies from a few days after operation to twenty-five years. There is often a period of comfort for six months or one year or several years following gastro-enterostomy, and then recurrence of a digestive complaint.

The symptoms may arise from a few months to several years after operation. A number of cases reported in the literature which did not give rise to disturbing symptoms till ten or twelve years after operation make it evident that one should not count his "cures" too soon.

Judd reports a case in which a definite secondary ulcer was demonstrated by X-ray five weeks after the original operation.

The symptoms of the secondary ulcer are often similar to those of the original ulcer: burning or gnawing pain after meals, which may or may not be relieved by food or alkalies. The pain is usually to the left of the midline, and considerably lower than that of ulcer of the stomach or duodenum. It may radiate to the lower abdomen, or to one or both iliac fossæ. As regards intensity of the pain, there is divergence of opinion, many authors stating that it is more intense than that associated with the original ulcer, sometimes becoming "unbearable"; but others finding it to be less intense. In our experience it is more severe and much less amenable to medical management, the usual relief measures having only a very transitory effect. All agree that there may be periods of remission.

Occasionally there is associated anæmia, and a stooping posture. Hæmatemesis and passage of blood from the bowel are sometimes observed.

Szemoe believes the periodicity of the symptoms and their tendency to become latent is one reason for postponing operation until medical treatment has been given a fair trial. It is also a reason why end-results should not be considered conclusive until several years after operation.

In advanced cases with exudate, there may be a palpable tumor.

There may or may not be hyperacidity. If there is, this should be reduced before operation, and it is important to determine the amount of free hydrochloric acid in outlining treatment.



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Lennander says there are no "pain-perceiving nerves in the stomach and intestine, and that, therefore, ulceration is painless until it invades the peritoneum, making determination of exact time of onset difficult."

Occasionally the patient may complain of pain on turning or twisting the body, raising the arms, or during a lifting strain, and this symptom is usually evidence of adhesions involving the abdominal parietes. (Eustermann.)

Although the relationship between discomfort and food intake is not always definite, it is usually sufficient to point to a lesion associated with gastric function.

In a certain group of cases, which Eustermann calls the "intestinal type", symptoms are all referred to the lower abdomen, and bear no relation to food. The pain is often associated with bloating or defecation, occasional diarrhœa, or severe constipation alternating with diarrhœa, at times presenting a clinical picture similar to that of intestinal obstruction, and the error of interpreting the symptoms as due to "irritable colon", colitis, etc., should be guarded against.

A definite mass is sometimes palpable in the umbilical region. Tenderness may be localized or diffuse. In patients with marked obstruction, visible peristalsis is found on physical examination.

The symptoms which arise in connection with gastrojejunal fistulas, the extreme stage of the ulcer, will be discussed separately.

*X-ray Findings.*—Case, approaching the subject from the röntgenologist's point of view, says:

"The one direct sign of a gastrojejunal ulcer is the evidence of an ulcer crater in relation to the stoma. One is able to see this only very rarely. More often there is a deformity about the stoma, narrowing and irregularity of the jejunum, and evidence of fixation at the site of the anastomosis, all of which are in contrast to the lack of deformity and perfect pliability of the jejunal walls and mobility of the stomach at the site of the anastomosis found in normal cases.

"Indirectly, dilation of the stomach and duodenum, delay in gastric clearance, and unusual activity of the gastric musculature, manifested either by spasm or by hyperperistalsis, suggest the presence of an anastomotic ulcer.

"There is a characteristic general excitation of the stomach and upper bowel recognizable by the experienced röntgenologist. Motor irritation may be suggested by (a) extreme, boardlike contractions of the stomach; (b) serration of the greater curvature; (c) spasm of the new stomach outlet, sometimes amounting to a total long-continued occlusion of the anastomosis, and (d) spastic contractions of the adjacent jejunum, recognizable by the fact that the first bolus of barium that passes is followed immediately by an occlusion that is spastic in nature and may or may not result in a prolonged gastric clearance. In other cases, there is often no disturbance in gastric mobility."

Tenderness on pressure over the gastro-enterostomy opening is highly suggestive. In observations made four hours after the administration of the barium meal, tenderness over a residual fleck of barium at the region of the stoma has proven of marked diagnostic value in our hands.

Carman calls attention to the deformity of contour about the stoma, exaggerated peristalsis, barium retention, spasticity or enlarged stomach, and the fact that the gastro-enterostomy is not freely patent.

Balfour says that fluoroscopic examination will be positive in 95 per cent. of cases.

Moore and Marquis find that the greatest difficulty in the X-ray diagnosis of

gastrojejunal ulcer is its differentiation from an improperly performed gastro-enterostomy. They mention two groups of X-ray findings in gastrojejunal ulcer:

"(1) Those indicating an abnormal condition in the anastomosed stomach, such as retention, hyperperistalsis, a large stomach, gastric spasticity, and duodenal dilation; and (2) deformities around the stoma, such as irregularity of the jejunum, a scanty flow through the opening, and fixation of the anastomosis site. It is of the greatest aid to the röntgenologist to know what type of gastro-enterostomy was performed."

*Diagnosis.*—When an interval of relief after gastro-enterostomy is followed by a return of symptoms referable to the digestive tract, a diagnosis of gastrojejunal ulcer is to be seriously suspected, although of course in a few cases they indicate reactivation of the original ulcer, the development of malignancy, or distress due to improper function of the gastro-enterostomy, particularly too rapid emptying of the stomach with jejunal dilatation. X-ray examination affords the most accurate method of differential diagnosis.

*Treatment.—Preventive Measures.*—The importance of these cannot be overemphasized. Gastro-enterostomy should not be undertaken lightly, and, once performed, careful and particularly persistent medical management post-operatively will greatly reduce the incidence of gastrojejunal ulcers.

*Medical Management.*—If a gastrojejunal ulcer is recognized clinically, many authors suggest, and we firmly believe, that medical management should be given a fair trial before resorting to surgery: (1) with the hope of affording relief; (2) to confirm the diagnosis; (3) to make the patient a better operative risk, if operation proves necessary, by first reducing the hyperacidity. We have now ten cases which are being handled quite satisfactorily with medical management from five years to six months.

Paterson considers the possibility of permanent relief by medical treatment very inconclusive, and states that although jejunal and gastrojejunal ulcers occasionally heal, the process of healing is apt to result in a condition requiring surgical intervention. Notwithstanding this, he believes, and we agree with him, that before an operation is performed for the secondary ulcer, the patient should undergo a course of careful dietetic and medical treatment.

If under medical treatment by diet, rest, and neutralization, pain disappears and the gastric acidity becomes diminished, this mode of treatment should be continued for at least six months. If, however, pain and hyperacidity persist, and if there is evidence of hypersecretion or gastric stasis, a continuance of medical treatment is of course futile. Medical treatment is more effective in those cases where a high acidity is found with the onset of symptoms.

*Surgical Procedures.*—If the clinical symptoms of ulcer have been verified by X-ray, and if these are not promptly relieved by medical measures, and the relief maintained, early and radical operation—partial gastrectomy—is the procedure most likely to be followed by complete relief of symptoms and cessation of ulcer development, although formerly it was customary to undo many gastro-enterostomies and make a new anastomosis, or to excise the ulcer and reconstruct the gastro-enterostomy. The percentage of recur-

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rence following these measures has been high, and in many of the reported cases after the patient has been subjected to several gastro-enterostomies, it has eventually become necessary to perform a radical operation. It is therefore wiser to resort to partial gastrectomy at once, but only if conditions for its performance are favorable.

The alternatives are (1) excision of the ulcer, when small, with enlargement of the original anastomosis; (2) cutting off the gastro-enterostomy, excising the lesion, closing the openings in the jejunum and stomach, restoring the alimentary tract to its original state; (3) pyloroplasty; and (4) jejunostomy.

Partial gastrectomy for gastrojejunal ulcer is often a difficult, time-consuming, and serious operation, and while it is undoubtedly productive of the highest percentages of maintained cures of this lesion, and has been the most satisfactory procedure in our hands, nevertheless, if applied in every case without regard for possible mortality factors, its death rate will be excessively high.

It is not possible to put in written words any set of rules adjustable to the variable factors which, when added to another variable factor, namely, the technical skill of the operator, make the operation one of greater or lesser risk. Nevertheless in general there are certain cases in which we know from our past experiences with them that the resection will be difficult. They are the patients who are still overnourished, with short fat-filled mesocolons which do not permit of ready delivery of the stomach. They are in the short individuals, who are also often difficult anæsthesia subjects. In such patients we still feel that excision of the gastro-enterostomy together with the stoma and closure of the stomach and jejunum, followed by dietary measures, will not result in the high percentages of complete relief which attends partial gastrectomy, but will at times be necessary if one would avoid an unjustifiable mortality. We have, as stated earlier in this paper, twice seen duodenal ulcer reappear following this procedure. In both cases the duodenal ulcer was found healed at the operation for the gastrojejunal ulcer, and recurred following excision of the gastro-enterostomy and restoration of the alimentary stream to its natural course. Both cases are progressing satisfactorily under medical management so far (one under treatment for two years, the other for six months), and we feel that they are suffering from the lesser of two undesirable states in that they were bad risks for partial gastrectomy.

The procedure of excising the ulcer and enlarging the stoma should be abandoned, since it has been followed by such a high percentage of ulcer recurrence, which is not remarkable because it in no way alters the pathological physiological processes which originated the gastrojejunal ulcer.

Pyloroplasty is applicable in the surgical management of this lesion only as an added step to excision of the gastro-enterostomy together with the ulcer and restoration of the alimentary canal to its original state. We have never employed it.

Jejunostomy should be reserved for those bad risk cases in which either partial gastrectomy or excision of the gastro-enterostomy stoma together with the ulcer would be an unjustifiable risk. We have not employed it in connection with gastrojejunal ulcer.

#### GASTROJEJUNOCOLIC FISTULÆ

The most unfortunate sequela of a gastrojejunal ulcer is a gastrojejuno-colic fistula, the first case of which was reported by Czerny four years after Braun published the first description of a jejunal ulcer. Verbrugge of the Mayo Clinic has recently (1925) made an exhaustive review of the subject.

He reports that 11.36 per cent. of the patients at the Mayo Clinic who had a gastrojejunal ulcer following gastro-enterostomy developed a gastro-jejuno-colic fistula also. Bolton and Trotter found that fistulæ develop in about 10 per cent. of cases of gastrojejunal ulcer, and Lion and Moreau report an incidence of 12 per cent. According to Verbrugge, .16 per cent. of all patients who have gastro-enterostomy develop fistulæ.

Two of our 16 cases had gastrojejuno-colic fistulæ.

Loewy, in 1921, compiled from the literature 76 gastrojejuno-colic fistulæ following gastro-enterostomy, and reported them in detail. At that time 185 cases of gastrojejuno-colic fistulæ from all causes had been reported. To these may be added 17 collected by Verbrugge, 14 not previously reported from the Mayo Clinic, and two from our clinic, making a total of 218 cases.

Fistulæ resulting from gastrojejunal ulcers represent the extreme stage of the evolution of these ulcers, and therefore the etiology must be considered that of the ulcer itself.

At operation many gastrojejunal ulcers are markedly adherent to the colon, due to the fact that when a gastro-enterostomy is done upon a patient with a short mesocolon and a low stomach, the colon lies just over the gastro-enterostomy stoma, particularly if the mesocolon has been attached to the stomach. If a gastrojejunal ulcer develops and is not operated on at this stage, a fistula soon results from the progress of the ulceration. "It is a remarkable fact that, immediately following the perforation, the jejunal ulcer is cured, the mucous membrane becomes normal in appearance, and the walls of the fistula, as described by Gosset, seem as 'if they had been neatly cut out by a surgeon's hand'."

*Pathology.*—During the formation of a fistula,—that is, while the jejunal ulcer is perforating the intestinal coats—there may or may not be a localized peritoneal reaction. This will partly determine the extent of the adhesions which will be found at operation, which may be entirely absent (Gosset), slight, or so extensive as to make operative procedure very difficult.

The manner in which the jejunal ulcer penetrates, and the technic of the gastro-enterostomy, particularly the fixation of the mesocolon to the stomach, will also influence the extent of the adhesions.

The fistula may be gastro-colic, jejuno-colic, or gastrojejuno-colic. The ulcer may develop on the wall of the jejunum opposite the gastro-enterostomy

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stoma; it often involves both gastric and intestinal sides of the suture line. Cases have been reported in which the ulcer developed 10 cm. from the stoma and yet produced a fistula. We have had one such case found in the course of gastric resection for gastrojejunal ulcer at the stoma.

The fistulæ are usually single. Even multiple ulcers rarely give rise to more than one fistula. The width of a fistula may vary from 1 mm. to 10 cm. The direction and length are also variable, and "the orifice may be hidden in folds of the mucosa, constituting a valve-like apparatus which may at times complicate the symptoms." The mucous membrane covering the fistulous tract is usually not markedly abnormal, but the efferent branch of the jejunum is often dilated, congested, thickened, and hypertrophied, due to constant irritation, at first by the acid contents of the stomach, and later by the fecal material from the colon.

Narrowing or stricture of the colon at the orifice of the fistula is not uncommon, and in extreme cases will cause distention of the cæcum with signs of intestinal obstruction, which may lead to erroneous diagnoses.

*Symptoms.*—These may begin from two and a half months after operation (von Eiselberg) up to twelve years later (Roux). In the series reported by Verbrugge, the minimal interval was nine months, and the maximal five years and four months.

The onset may be marked by sudden diarrhœa, by abdominal cramps and colics accompanied by vomiting of fecal material, or it may be insidious. Foul eructations and loss of weight and anæmia are significant. Pain is rare, inconstant, and variable, but stricture of the colon may cause obstructive symptoms. Loss of weight, which is apt to be rapid and considerable, often makes the operative risk poor.

Physical signs seem to be of little value, because of their variability. *Diagnosis.*—The symptoms just enumerated, plus a history of gastro-enterostomy and possibly of jejunal ulcer, make the diagnosis of gastro-jejunocolic fistula comparatively easy. In doubtful cases certain diagnostic aids are available: the use of colored meals which appear rapidly in the stools; the recovery of colored material by gastric tubage after a colored enema; insufflation of the rectum provoking rapid distention of the stomach; gastric lavage producing loss of fluid, and, of course, X-ray examination. Firth considers the X-ray pathognomonic, but in eight of the Mayo Clinic cases it was negative, and in one, doubtful.

Cividali has given the X-ray characteristics as follows: irregular contour of the stomach, signs of perigastritis with limited mobility of the stomach; passage of bismuth into the colon; presence of bismuth in the descending colon and sigmoid, and absence in the ascending colon; possibility of provoking the passage of bismuth from the colon into the stomach by palpation, and presence of bismuth in the stomach following a bismuth enema. In a case recently seen by us, the first fluoroscopic examination showed barium passing from the jejunum into the colon, but this phenomenon could not

be reproduced in later observations. Subsequent operation showed the presence of the fistula.

*Recurrence.*—The fistulæ, like the ulcers which lead to their formation, have a tendency to recurrence, as pointed out by Loewy (11.1 per cent.).

*Treatment.*—Unless surgical measures are instituted, the outcome is likely to prove fatal in the majority of cases. The preventive measure of diminishing the incidence of gastrojejunal ulcers is of course the desired end. Fistulæ may be at least guarded against by making a high opening in the posterior leaf of the gastrocolic omentum, so that the anastomosed jejunum as it passes through this opening is held away from the transverse colon.

Pre-operative treatment, though sometimes advisable, should not be long continued, as the patient will continue to lose weight and the operative risk be thus increased. Enemas should be avoided. The poor condition of patients with gastrojejunal ulcer and colonic fistula, together with technical difficulties consequent to the adhesions, as well as the danger of soiling from colon contents, mitigate strongly against extensive operative procedure. Excision of a gastro-enterostomy with the gastrojejunal ulcer, together with closure of the fistulous tract will, we believe, be followed by the lowest mortality and, in spite of the possibility of recurrence of the original duodenal ulcer, as occurred in two of our cases, is the most justifiable procedure.

#### CONCLUSIONS

A majority of the ulcers recurring after gastro-enterostomy are gastrojejunal ulcers and not recurrences of the original ulcers. There are many more gastrojejunal ulcers in existence than we have heretofore assumed. They are the most dangerous of all types of ulcer, and so serious and frequent are their complications that they demand very early discovery, and with failure to obtain relief and low acidity with medical treatment demand prompt and the most complete eradication.

# PROGRESSIVE GANGRENOUS ULCERATION OF THE ABDOMINAL WALL

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IN *Surgery, Gynecology and Obstetrics* for May, 1924, Dr. Thomas Cullen<sup>1</sup> described an extensive serpiginous ulceration of the abdominal wall and in the Chicago number of *Surgical Clinics of North America* for June, 1924, Dr. Frederick Christopher<sup>2</sup> reported a similar case. At the meeting of the American Surgical Association in Washington in May, 1925, Dr. George Brewer<sup>3</sup> reported two of his own cases and spoke of five other cases, two of which were Christopher's mentioned above. In addition to these there is a report by Dr. Tomosuke Mayeda<sup>4</sup> in *Deutsch. Ztschr. f. Chir.*, for 1926.

On May 11, 1927, there was admitted to my service in the University Hospital of Baltimore, a man with a large, progressive and gangrenous ulcer occupying the entire left half of his upper abdominal wall and extending well up on the chest. He was sent in by Dr. R. W. Patterson, of Clarksburg, W. Va. He had been operated on at his home in West Virginia on January 5, 1927, for what was diagnosed as abscess of the abdominal wall. This incision was on the right side and about opposite the umbilicus. He was operated on again on January 19, and a second abscess to the left of the midline drained. This abscess contained about 100 c.cm. of pus with a colon odor. Following this the history is that four small pimples about the size of a grain of wheat appeared adjacent to the wound. The skin became brown in color, but the physicians did not pay much attention to this at the time. These pimples ruptured spontaneously and some pus escaped. These infected areas spread rather rapidly in all directions until the larger portion of the entire left abdominal wall was involved. Many different antiseptics were tried, but in spite of all methods of treatment the infection spread. He was in the hospital for seventeen weeks and left the hospital with the process still extending. After leaving the hospital he went home and was treated by his physician for three weeks. The infection continued to spread, the patient's general condition became worse and he then went to another hospital near his home where the wound was treated for four weeks with Dakin's solution, but the ulceration continued to advance. He left the hospital and went home and on May 11, 1927, as stated above, was admitted to the University Hospital.

At this time the lower portion of the ulcerating surface had begun to heal. The middle portion of it was occupied by a large granulating surface and there was a long, spreading margin extending in a wide semicircle from the midline of the abdomen just above the navel onto the costal margin and chest wall and downward on the lumbar region to the crest of the ileum behind. This advancing margin presented a number of zones. There was a narrow strip of black, necrotic tissue adjacent to the ulcer. Just beyond this there was an œdematous, dusky red and swollen area about 6 or 7 cm. wide and beyond this the swelling gradually merged into normal looking tissue. The patient's general condition was bad. His morale was very low, he had lost a great deal of weight and his chief complaint was exquisite tenderness over the entire area when it was handled in any way. He was kept under observation and the area painted over several times a day with mercurochrome, but without any improvement.

May 17 he was taken to the operating room and, under gas anæsthesia, the entire advancing border of the ulcer cauterized. The cautery was thrust through the skin and a linear cauterization done parallel to the advancing ulcer and beyond the red, cedematous area. The strip of infected and necrotic ulcer was then excised by means of a scalpel and the denuded surface thoroughly cauterized. This arrested the ulcer, except in two small areas where evidently the cauterization was not carried beyond the advancing infection. Here, a semicircular, spreading ulceration developed and these areas were again cauterized one week later.

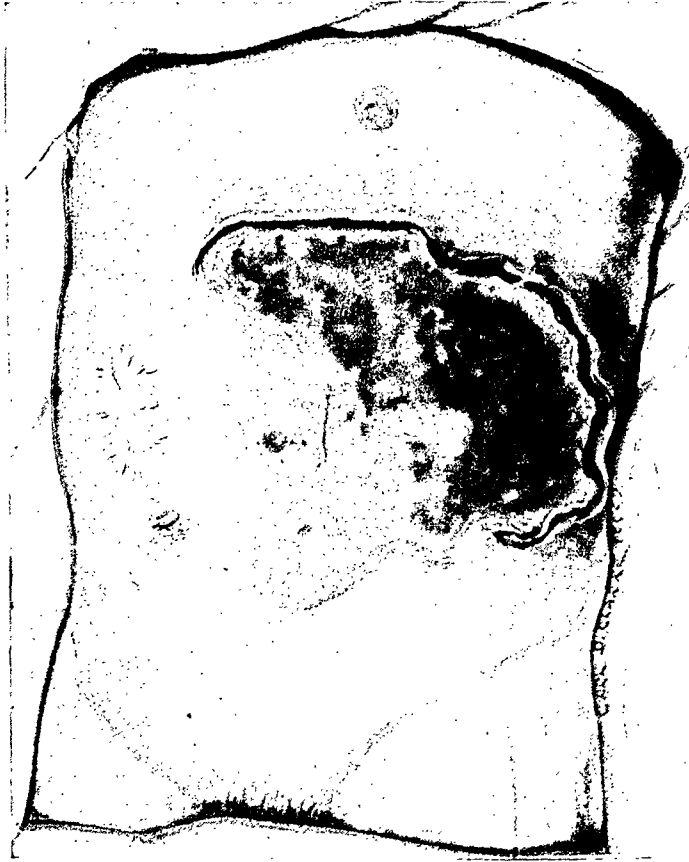


FIG. 1.—Appearance of lesion on admission.

Following this, there was no further spread of the ulceration. The surface was Dakinized and gradually cleaned up. Four weeks later, a small area was covered by pinch grafts taken from the thigh to determine whether or not these grafts would live on a surface that had been so heavily infected. The grafts behaved very satisfactorily and at intervals of a few days the entire ulcerated area was covered by pinch grafts. This was done at four different operations. The last grafting was done on July 18, 1927, and 140 pinch grafts were placed on various areas of granulating surface. Practically all of the grafts lived. They were taken from the anterior surface of the thigh under local

anæsthesia. He left the hospital on August 9, 1927. The entire wound at this time was practically healed. I heard from his doctor about a month later, at which time he reported that the patient had entirely recovered; that the ulcerating surface was completely healed; and that he had gone back to work.

The original condition of this man was diagnosed abscess of the abdominal wall and was said to be of unknown etiology. The scar left by the drain tract was about 5 cm. to the right of the midline and just above the level of the umbilicus. From his history he probably had a high appendix with a walled-off abscess which was adherent to the abdominal parietes.

Bacteriologically the study of the tissue removed in my own case threw no special light on the infection. Smears made at the time of operation showed numerous pus cells and Gram-positive cocci in chains. Culture showed a non-hæmolytic streptococcus.

In Cullen's case "the only microörganism found was the streptococcus brevis."



## PROGRESSIVE ULCERATION OF ABDOMINAL WALL

In Mayeda's case the formation of the ulcer was attributed to a bacillus resembling the diphtheria bacillus, which he believed reached the infected area from the appendix.

In Christopher's case, the ulcer followed drainage of an empyema and the "direct smear of the pus from the pleural cavity was reported; Gram-positive cocci in chains; long slender Gram-negative bacilli. The anaërobic culture revealed small round Gram-positive cocci in chains, resembling streptococci and Gram-negative bacilli. There was a very slow growth of hæmolytic streptococci on aërobic media."

In Brewer's cases a careful bacteriological study was made by Meleney and the organisms recovered from the infected area were injected into both guinea-pigs and rabbits. A pure culture of a non-hæmolytic streptococcus was gotten from the peritoneal abscess at the time of the operation for appendicitis. Later cultures made from the gangrenous ulcer showed a hæmolytic staphylococcus aureus and a diphtheroid bacillus. At this time the streptococcus was not found. "Subsequently a special study was made of the slough from the wound. A hæmolytic staphylococcus aureus and a diphtheroid bacillus were found again aërobically, while the anaërobic blood agar plates revealed a streptococcus which would not grow on the aërobic plates." Animal inoculation was done in order to show the relation of these organisms to the ulcer. The excised ulcer was carried to the laboratory in a sterile towel and the surface painted with iodine and incisions were made into this tissue just beyond the gangrenous margins. Direct smears from the tissues showed a large number of very small cocci. These organisms turned out to be a non-hæmolytic streptococcus. The hæmolytic staphylococcus and the diphtheroid bacillus were not found away from the gangrenous margins.

Animal experimentation showed rather conclusively that for the formation of these gangrenous, serpiginous ulcers in animals, two organisms were neces-

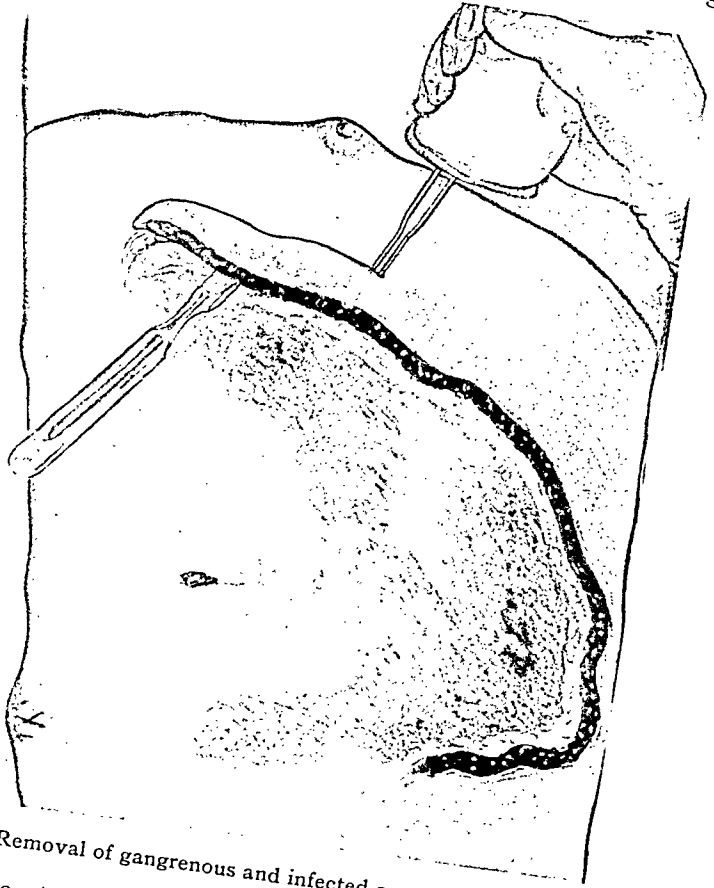


FIG. 2.—Removal of gangrenous and infected area with cautery.

sary: the non-hæmolytic streptococcus and the hæmolytic staphylococcus aureus; "these when injected together, produced gangrene almost invariably, while these organisms injected separately did not. The streptococcus never, and the staphylococcus only rarely in small guinea-pigs." Brewer's suggestion of symbiosis, with the experimental work supporting it, is a very enlightening thing. These gangrenous ulcers resemble very closely much of the behavior of carbuncles and it is quite possible that the specific nature

of carbuncles is due to a combination of special strains of staphylococci and streptococci working together.

All of these ulcers resisted ordinary treatment. Almost every sort of germicide was used. These agents had a good effect upon the granulating surface of the ulcer, but did not control the advancing gangrenous edge. Neither heat, cold, light nor other types of radiation had the slightest deterrent effect upon the spread of the ulceration.

In each instance the spreading necrotic edge was controlled only by

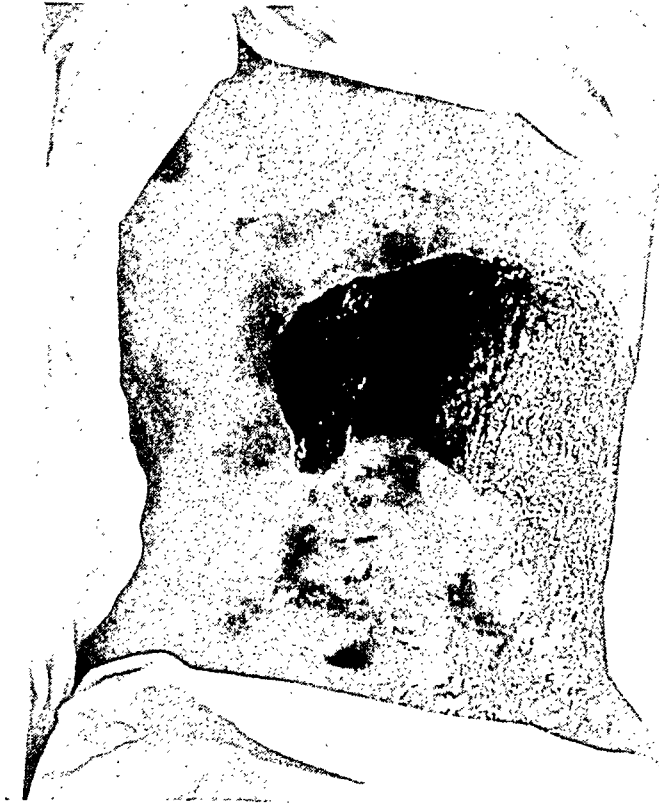


FIG. 3.—Ulcerated area after cauterization; clean and healthy. This surface was later covered with pinch grafts.

very drastic surgical measures. Cullen cut away the edge of the ulcer with a cautery, burning about a half inch from the ulcerated area. Christopher at first excised the margin with a scalpel, but bleeding was so profuse that he finally resorted to the cautery. Mayeda excised the margin. Brewer "circumscribed the entire diseased area, well beyond the lesion by an incision through the skin and entire thickness of the subcutaneous fat to the sheath of the rectus and aponeurosis of the external oblique muscles and packed this incision with gauze wet with a 1 per cent. solution of formalin. The sloughing process did not extend beyond this barrier."

In my own case, under general anæsthesia, I produced a gutter wound with the cautery, well beyond the œdematous area of the skin and then cut away the ribbon of infected sloughing material between this cauterized line and the margin of the ulcer and cauterized the raw surface.

# PROGRESSIVE ULCERATION OF ABDOMINAL WALL

## CONCLUSIONS

These carbuncular-like and spreading, gangrenous ulcers are probably more common than the literature would indicate.

The work of Brewer and Meleney suggests that a combination of special strains of streptococci and staphylococci may account for the peculiar and specific nature of the lesion.

Most of the reported cases have followed suppurative appendicitis with drainage and the ulceration developed in the majority of instances a week or more following operation and behaved very differently from ordinary wound infection complicating drainage.

These lesions resist all ordinary treatment and in every instance were controlled only by complete excision, isolation or destruction of the advancing infectious area.

The cautery is a very useful instrument in checking the ulcers.

The large denuded surfaces have healed in some instances without grafting, but grafts live very well on the granulating surfaces and shorten the period of convalescence.

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# SOLITARY CYSTS OF THE KIDNEY\*

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Cysts of the kidney were described by Fabry<sup>1</sup> of Hilden, the "Father of German surgery", who died in 1624, and Thomas Willis<sup>2</sup> the English clinician of the seventeenth century. Morgagni<sup>3</sup> described the renal cysts.

Rayer<sup>4</sup> in 1837 classified different types of renal cysts, according to their contents. Cruveillier,<sup>5</sup> Lejars<sup>6</sup> and Virchow<sup>7</sup> made similar observations.

Laveren<sup>8</sup> in 1876 made a clear distinction between single renal cysts and polycystic kidney. While Lancereaux in 1876 divided the large isolated cysts of the kidney into two classes—serous and hemorrhagic, of the former. Morris<sup>9</sup>

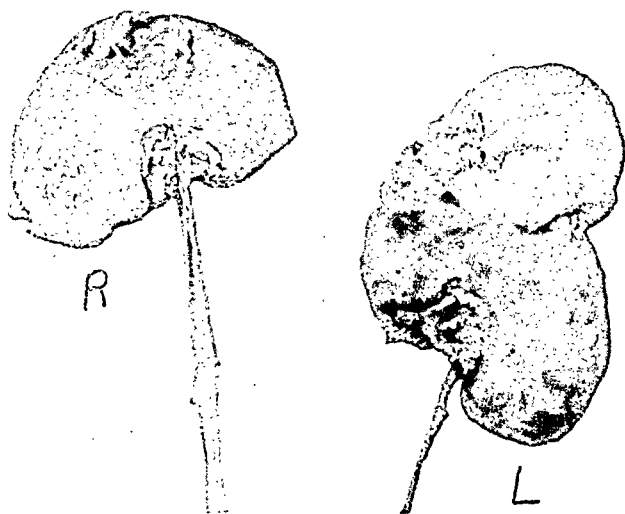


FIG. 1.—Case I. Large solitary cyst (capacity 800 c.c.) at upper pole of left kidney. Right kidney presents a cyst measuring 2.5 cm. in diameter at upper pole and a smaller cyst close to the hilum.

found 5 cases in 2610 autopsies at the Middlesex Hospital, London. In 1906, Simon<sup>10</sup> was able to find but 52 cases reported in the literature.

Kretschmer,<sup>11</sup> in 1920, collected 47 cases appearing in the literature after Simon's review and added a case of his own.

Harpster, Brown and Delcher,<sup>12</sup> in 1923, tabulated but 95 cases. McKim and Smith,<sup>13</sup> in 1924, collected 117 cases from the literature and added three of their own. Kretschmer,<sup>11</sup> Harpster<sup>12</sup> and McKim<sup>13</sup> reviews do not include Kelly's and Burnam's<sup>14</sup> 2 cases. Guiteras<sup>15</sup> one case and Quinby's<sup>16</sup> 3 cases. To the above 126 cases, may be added 15 cases which have appeared in the literature between 1923 and 1927. Viz: Lewis,<sup>17</sup> G. G. Smith,<sup>18</sup> Herrick,<sup>19</sup> Swarz,<sup>20</sup> O'Neil,<sup>21</sup> Gonczyzy,<sup>22</sup> Delore and Mallet,<sup>23</sup> Petal and Mallet,<sup>24</sup> Viethen,<sup>25</sup> Santors,<sup>26</sup> Kirwin,<sup>27</sup> Alessandri,<sup>28</sup> Joseph<sup>29</sup> and Fullerton,<sup>30</sup> Fullerton collected but 98 cases from the literature.

As solitary serous cyst of the kidney is rare, the following 4 cases are reported, making a total of 145.

\* Read before the North Central Branch, American Urological Association, October 14, 1927.

## SOLITARY CYSTS OF THE KIDNEY

*Etiology.*—Three views are held: (1) That they are due to embryonal rests; (2) that they are due to failure of union between the glomeruli, and the collecting tubules; and (3) that they are retention cysts, due to constriction of the tubules by fibrous tissue or blocking of the glomeruli or tubules by desquamated and degenerated cells, favored perhaps by small hemorrhages.

In the development of the functional kidney or metanephros, it will be recalled that it has a double origin, the ureter, renal pelvis, calyces, and straight collecting tubules or ducts arising from the so-called ureteric bud, a diverticulum of the more primitive wolffian duct, and the coiled uriniferous or secretory tubules "Crystallizing," so to speak, from the metanephrogenic blastema into which the ureteric bud grows. The blind expanded end of the bud becoming the primitive renal pelvis, it now gives rise to the different successive generations or orders of straight collecting ducts. During this process, the metanephric blastema, which always caps the ampullæ or blind terminations of the last ducts formed, is divided in such a way



FIG. 2.—Case II. Solitary cyst of kidney 25 by 20 cm. extending from superior to inferior pole along the convex surface.

that one part is raised or carried peripherally by the newly sprouting ones while the other part stays behind in the form of separate masses which lie in contact with the sides of the parent ducts. As this process is repeated every time a new generation of ducts is produced, generation after generation of potential uriniferous tubules are likewise laid down and accordingly arranged in successive tiers as one proceeds from centre to periphery. Soon after those metanephric masses are split off from the blastema, they round out to form what are known as "metanephric spheres". By the acquisition of the cavity they become converted into the "metanephric vesicle". By further growth

and change they attain the typical S-shaped stage, one end establishing continuity with the respective collecting duct, and the other forming the glomeruli capsule. Continued growth, extension, convolution and histological differentiation create the definite characters of the uriniferous tubules. Kampmeier<sup>31</sup> has recently shown that every human individual during his foetal life normally passes through a period characterized by the presence of numerous cystic renal tubules. Such a normal physiological event, however,

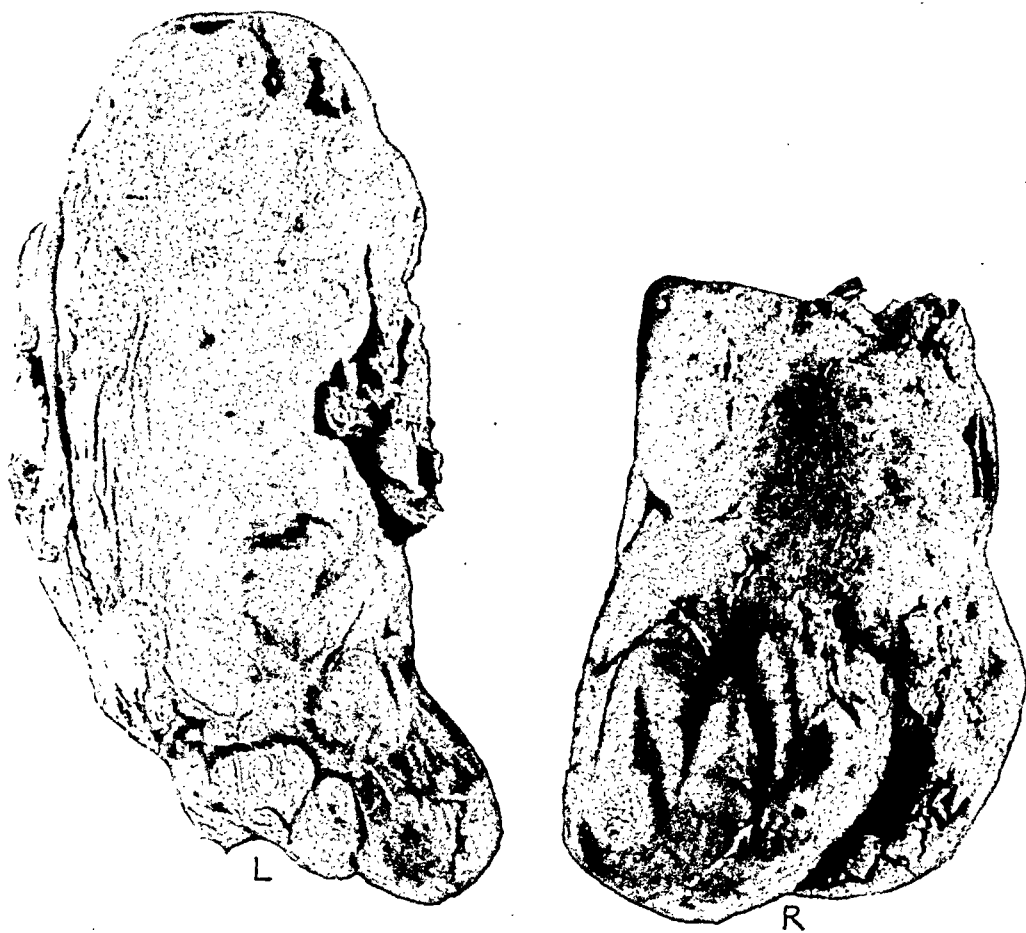


FIG. 3.—Case III. Solitary cyst lower pole of right kidney 15 by 10 cm. Lower pole of left kidney 8 by 4 cm.

may be converted into an abnormal or pathological condition if such tubules do not give way at the end of their allotted time but continue to grow and expand to the detriment of adjacent normal structures. Should one do this, it is readily understood how it might produce renal cysts.

*Pathology.*—Solitary serous cysts of the kidney are usually, unilateral, with the cyst located in the upper or lower pole, in a few of the reported cases it has occupied the anterior surface of the kidney or the hilum. The right kidney has been involved more frequently than the left. McKim and Smith found the lower pole involved in 51 and the upper in 21 instances, with 8 occupying the centre of the kidney. The size of the cysts vary from 30 c.c. to 16,000 c.c. Goneyzy,<sup>22</sup> with the average being 15 cm. in diameter.

## SOLITARY CYSTS OF THE KIDNEY

The cyst wall is grayish-white in color with blood-vessels visible on its surface; on section the wall measures from 1 to 3 mm. in thickness, with the inner surface smooth and glistening, occasionally being multiloculated in character. The cyst wall is independent of the kidney capsule, but blends with the interstitial fibrous tissue of the renal cortex. Near the cyst the kidney substance usually shows pressure atrophy. No communication is found between the cyst and the kidney pelvis or calyces.

Microscopically the wall is found to be composed of fibrous connective tissue. Lauenar describes a lining made up of normal cell formation of the uriniferous tubules somewhat flattened in appearance. Carnil and Babinski describe a layer of pavement epithelium surrounded by a few cuboidal cells. Kelkeskamp found a complete lining of cuboidal epithelium. Bonneau and Hartmann found flattened epithelium with elongated cells which suggested endothelium, in some areas, while Lécène and Papin found cuboidal cells.

The majority of cases have shown no epithelial lining which may be due to ante-mortem or post-mortem changes.

The portion of the cyst wall which is nearest the kidney may show remnants of renal cortex. Small round-cell infiltration may be present, with calcareous deposits reported by a few observers. Brin<sup>33</sup> and Begg<sup>34</sup> who have collected 13 cases of solitary hemorrhagic cysts of the kidney from the literature, described the wall as being composed of three layers, (1) an inner layer of clots and fibrin; (2) a middle fibrous layer; and (3) an outer layer formed by renal parenchyma atrophied and sclerosed.



FIG. 4.—Case IV. Solitary cyst at lower pole measuring 6 by 4 cm.

## CONTENTS

In the majority of cases the contents are described as clear serous fluids. Bloody fluids or clot being found in a few instances. In Kretschmer's case

the larger cyst contained old clotted blood and the smaller cysts, clear straw-colored fluid.

*Associated Abnormal Conditions.*—Complicating these cysts the following have been found: Hypernephroma, carcinoma of the kidney, papillary carcinoma of renal pelvis, horseshoe kidney, abnormalities of renal blood-vessels, bifid pelvis, hydronephrosis, renal calculi and tuberculosis of the kidney.

*Age and Sex Incidence.*—Age: The majority of cases reported were between thirty and sixty years, average forty-five years. Two were one year old, one was four and one eight years. The oldest was a male, age eighty-nine years, the cyst being successfully resected by Bockenheimer<sup>25</sup> from a horseshoe kidney.

Sex: The condition is more frequent in females, of the 145 recorded cases. Forty-one were in males, and 89 in females, and in 16 the sex was not stated.

CASE I.—F. V., white male, age sixty-two years. Clinical diagnosis: *Carcinoma of the bladder; hypertrophy of the prostate; Von Recklinghausen's disease.* Kidney.—Left: The left kidney has a large single cyst at its upper pole, which holds approximately 800 c.c. of clear fluid. Below the cyst, the surface of the kidney is of a bright red color and is finally granular in appearance. Right.—On the anterior surface of the upper pole is seen a cyst measuring 2.5 cm. in diameter, and on the lower pole close to the hilum, a small cyst measuring 1 cm. in diameter is seen. The surface of the kidney is finally granular in appearance, with the pelvis and calyces markedly dilated. The right ureter is markedly dilated from the bladder wall to the uretero-pelvic junction measuring from 1.5 to 2 cm. in diameter.

Microscopically.—Section from the cyst wall showed it to be composed of fibrous connective tissue.

Anatomical Diagnosis.—Carcinoma of the bladder involving the base and lateral wall, obstructing the right ureteral orifice; hydro-ureter, right; hydronephrosis, right; solitary serous cyst of the left kidney.

CASE II.—Museum No. E—30—51,628 C. White female, age forty-five years. *Nephrectomy by Doctor Ashby for tumor of the kidney.* Kidney.—There is a large cyst extending from the superior to inferior pole along the convex surface which measures 25 by 20 cms. (after fixation in formalin). The wall is grayish-white in color with numerous blood-vessels visible on its surface. It is filled with clear fluid.

Microscopically.—Section of the wall is composed of fibrous connective tissue, with a few small round cells infiltrating in a disorderly fashion between the connective-tissue cells.

CASE III.—Museum E—7—51,628 B. Autopsy No. 290. Colored male, age twenty-five years. Clinical diagnosis: *Typhoid fever.* Kidneys.—At the lower pole of each kidney there is a large cyst. The right measuring 15 by 10 cm. and the left 8 by 4 cm. The walls are thin and of a grayish-red color. They are filled with blood-tinged fluid.

Microscopically.—Sections show adult fibrous connective tissue with a few blood-vessels filled with red blood-cells.

CASE IV.—Museum E—25—51,628. *Nephrectomy by Doctor Winslow.* Kidney.—The kidney shows a large cyst at the lower pole which measures 6 by 4 cm., which is grayish-red in color. A few blood-vessels are visible on its surface. It is filled with turbid fluid. The kidney is dark red in color, with a granular surface.

Microscopically.—Section from cyst wall shows a thick layer of fibrous connective tissue with a moderate small round-cell infiltration. Section from kidney shows chronic diffuse nephritis.



# SOLITARY CYSTS OF THE KIDNEY

## DISCUSSION

From a review of the literature and a study of the four cases reported above, it is the opinion of the writer that polycystic kidney, solitary serous cyst of the kidney and solitary hemorrhagic cyst of the kidney are all the result of congenital malformations of the kidney and that the solitary hemorrhagic cyst is formed in the same way as the solitary serous cyst.

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# POSTERIOR EXCISION OF THE SEMINAL VESICLES\*

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THE anatomic relations of the seminal vesicles and their relative inaccessibility have greatly augmented the difficulty of surgical extirpation under all conditions. The variety of surgical procedures that have been advocated is in itself evidence that no one method has been applicable to all cases under conditions of actual disease in the vesicles when the indications for extirpation were clear. Such indications have in the past been far from

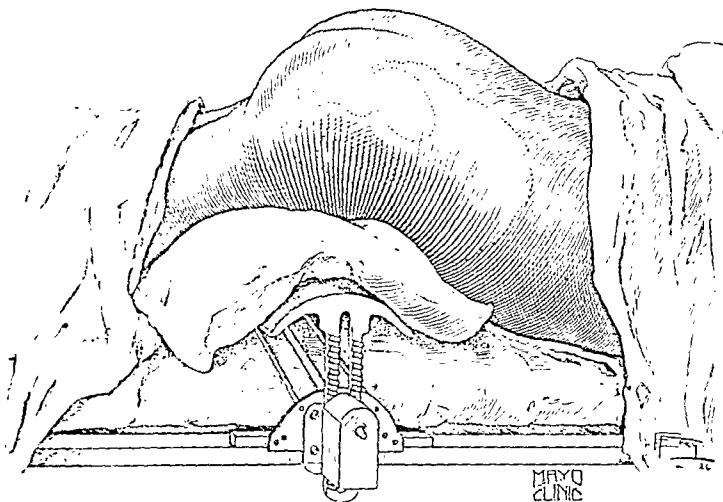


FIG. 1.—The prone position on the table with elevation of the pelvis tends to elevate the pelvic structures, including the seminal vesicles, into the operative field from a relatively deep position.

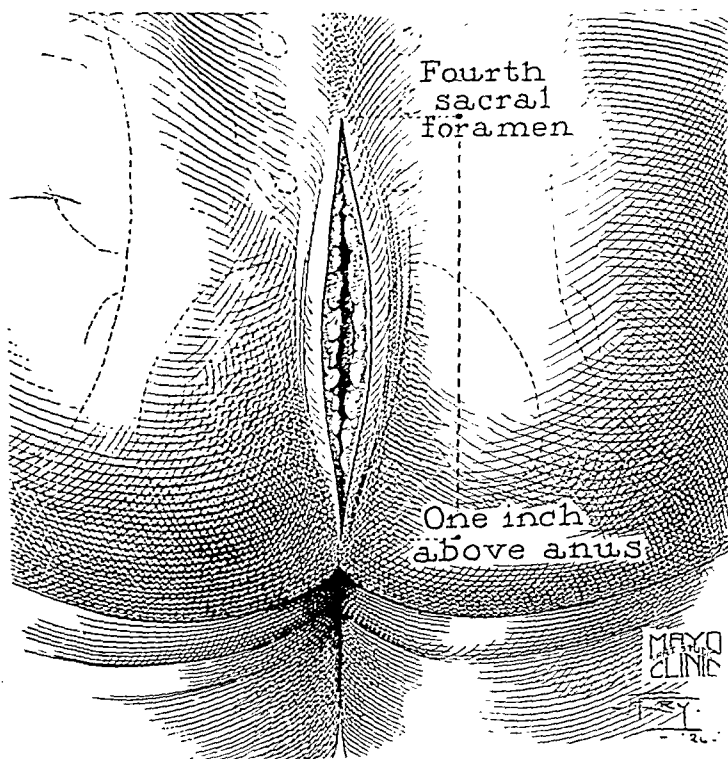


FIG. 2.—The incision in the median line extends from about 2.5 cm. above the anus to just above the sacrococcygeal articulation.

clear. A cursory review of the literature reveals numerous conditions for which the operation has been performed, chiefly urinary infection, impotency, nervous and mental disturbances and rheumatic conditions. It is obvious that the indications have been unrestricted. An unbiased analysis of the results of extirpation of the seminal vesicles narrows its applicability to a very small group of unquestionable pathologic conditions in the vesicles, not amenable to non-

\* Read before the North Central Branch of the American Urological Association, Madison, Wisconsin, October 14, 1927.

operative treatment. In the consideration of the question of extirpation of the vesicles in the individual case, the basis of the decision should rest on the pathologic condition rather than on the uncertain hope of improvement in sexual power, relief of mental disturbances, and benefit in rheumatic conditions.

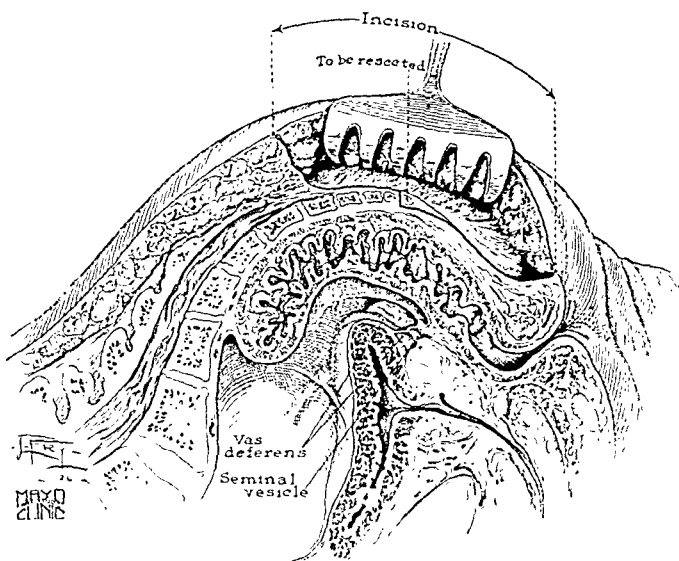


FIG. 3.—Sagittal section showing the accessibility of the vesicles by lateral retraction of the rectum after mobilization of the upper portion of the rectum and sigmoid.

densely adherent and at best may only be drained or incompletely removed. Fuller has reported a large series of cases in which extirpation was accomplished by a formidable operation in which, by a deep transverse perineal and two long lateral incisions, one on each side of the anus, the entire anus and rectum were elevated and displaced posteriorly to expose the prostate and seminal vesicles. The Rydygier incision likewise embraces a formidable procedure in the transverse division of the sacrum.

In the operation of posterior resection of the rectum for carcinoma, I have frequently noted the accessibility of the seminal vesicles through the posterior incision. A modification of this incision, avoiding displacement of the anus and obviating injury to the anal sphincters, seemed to afford a logical approach to the seminal vesicles. Furthermore, it seemed that the employment of the methods of mobilizing

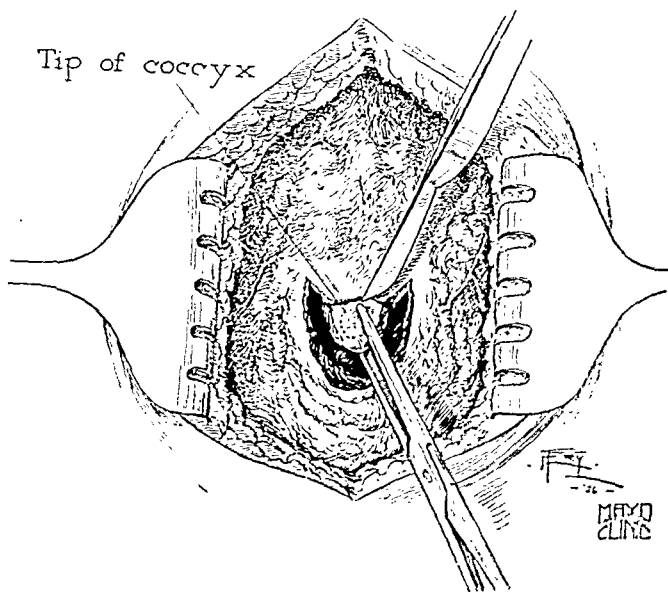


FIG. 4.—Knife excision of the tip of the coccyx.

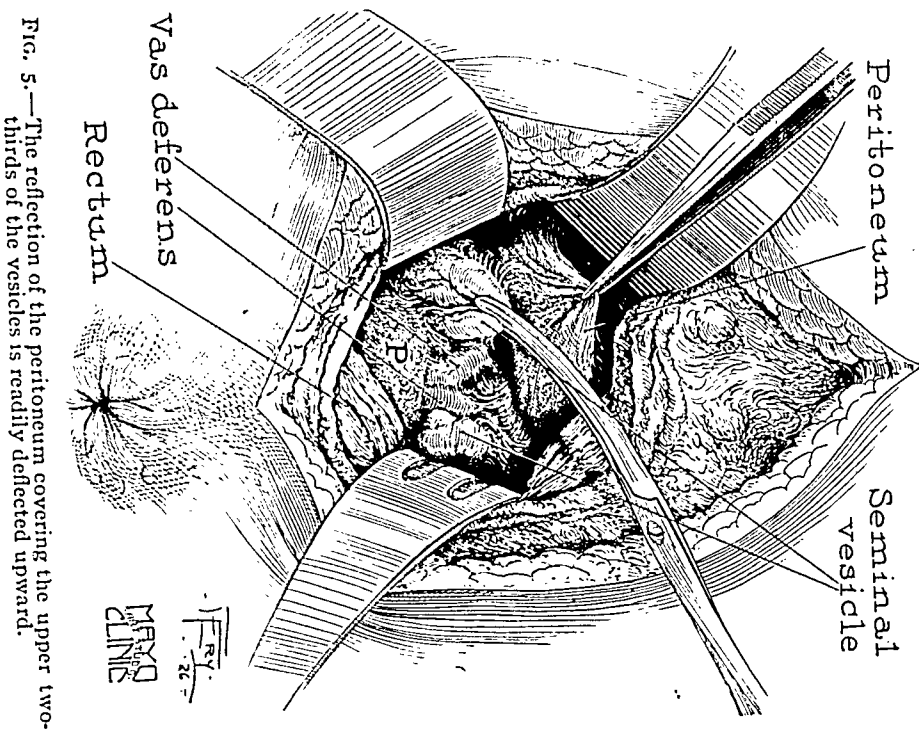


FIG. 5.—The reflection of the peritoneum covering the upper two-thirds of the vesicles is readily deflected upward.

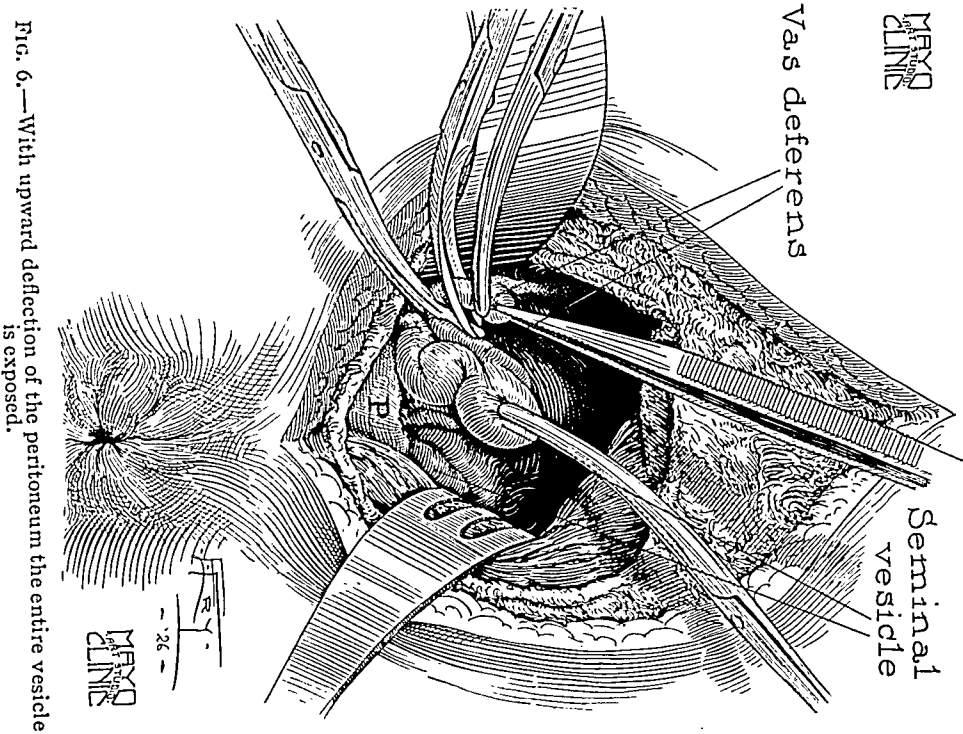


FIG. 6.—With upward deflection of the peritoneum the entire vesicle is exposed.

the upper portion of the rectum and sigmoid, as is the practice in posterior resection of the rectum for malignant disease, should afford adequate exposure of the seminal vesicles. The method has now been used in five cases in all of which the vesicles were densely adherent by virtue of extensive perivesicular inflammatory reaction.

The type of anæsthesia and the position of the patient are important factors in obtaining complete relaxation and adequate exposure through a

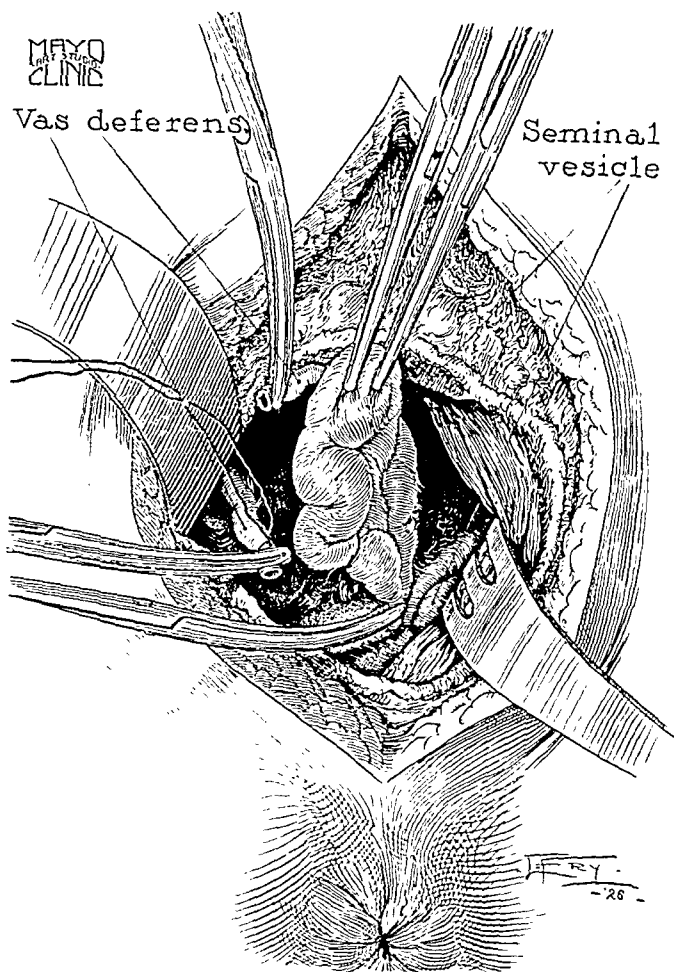


FIG. 7.—Complete extirpation of the vesicle with or without ligation of the vas.

relatively small incision. Complete relaxation is necessary and is best accomplished by the use of sacral anæsthesia, as described by Labat and Lundy. The prone position on the table with elevation of the pelvis (Fig. 1) tends to elevate the pelvic structures, including the seminal vesicles, into the operative field from a relatively deep position. The incision is made in the median line extending from about 2.5 cm. above the anus, or sufficiently far above the anus to avoid division of the anal sphincters, to just above the sacrococcygeal articulation (Figs. 2 and 3). The incision is carried down to the levators and which are divided in the anococcygeal raphe. Lat-

eral retraction of these muscles immediately exposes the rectum supported more or less loosely by areolar tissue. Excision of the tip of the coccyx (Fig. 4) facilitates mobilization of the rectum and lower portion of the sigmoid by detaching them from the anterior surface of the coccyx and sacrum. I would emphasize the fact that detachment of the rectum and lower portion of the sigmoid from the anterior surface of the coccyx and sacrum obviates the necessity of excision of the entire coccyx or the higher transverse division of the sacrum, which has been advocated in the more formidable methods of posterior excision of the vesicles. The disarticulation of the tip of the coccyx with mobilization of the rectum facilitates lateral retraction of the rectum

## POSTERIOR EXCISION OF THE SEMINAL VESICLES

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and provides adequate exposure for extirpation of the seminal vesicles. The seminal vesicles, as they lie above the prostate, extend laterally and posteriorly around the anterior and lateral aspects of the rectum, which they in reality embrace, and are separated from the rectum in their lower third only by the retrovesical fascia. The reflection of the peritoneum covers the superior two-thirds of the vesicles (Fig. 5), and is readily deflected upward after division of the rectovesical fascia. Mobilization of the rectum and lower portion of the sigmoid and their lateral retraction immediately expose the vesicles after division of the rectovesical fascia; accurate visible dissection and complete extirpation of the vesicles are thus facilitated (Figs. 6 and 7). After removal of one vesicle the rectum is retracted to the opposite side and the other vesicle removed in a similar manner. Extirpation of the vesicles may be accomplished without ligation of the vas deferens; however, in the presence of marked inflammatory reaction division of the vas may be necessary. Troublesome hemorrhage has not occurred in any instance, and the moderate oozing sometimes encountered has been controlled by a light gauze pack left in place for several days. Inasmuch as marked perivesicular infection has always been present, it has seemed advisable to institute drainage in all cases (Fig. 8). In none of the cases of the vesicles the wound is closed by suturing levators and together in median line. In all instances healing occurred without disturbance of function of levators or of anal sphincters.

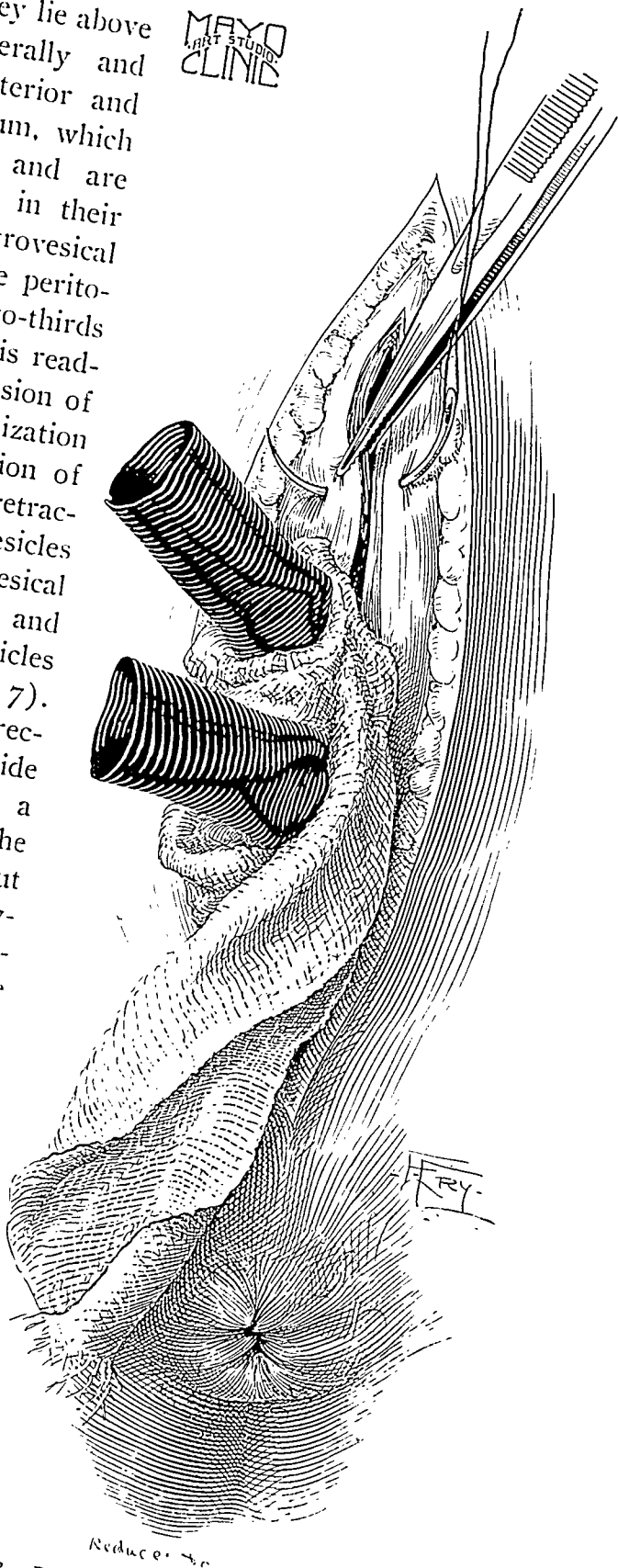


FIG. 8.—Rubber-tissue-and-gauze drain extending into the bed of the extirpated vesicle on each side.

In summary I would emphasize the restriction of the indications for seminal vesiculectomy to such cases of actual disease of the vesicles, not amenable to non-operative methods of treatment, as offer reasonable probability of benefit to the patient through the extirpation and removal of diseased structures. The indications on a functional basis are questionable. When the indications for seminal vesiculectomy are clear and based on definite pathologic changes in the vesicles, the method herein described is not formidable, obviates danger of injury to the anal sphincters, and facilitates visible extirpation of the vesicles.



# MALIGNANT TUMORS OF THE TESTICLE

By CHARLES CLAIR HIGGINS, M.D.

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*Classification and Origin.*—The origin and classification of malignant tumors of the testicle has been a subject of controversy ever since St. Donat<sup>23</sup> wrote on the subject in 1696. As the result of their investigations Langhans

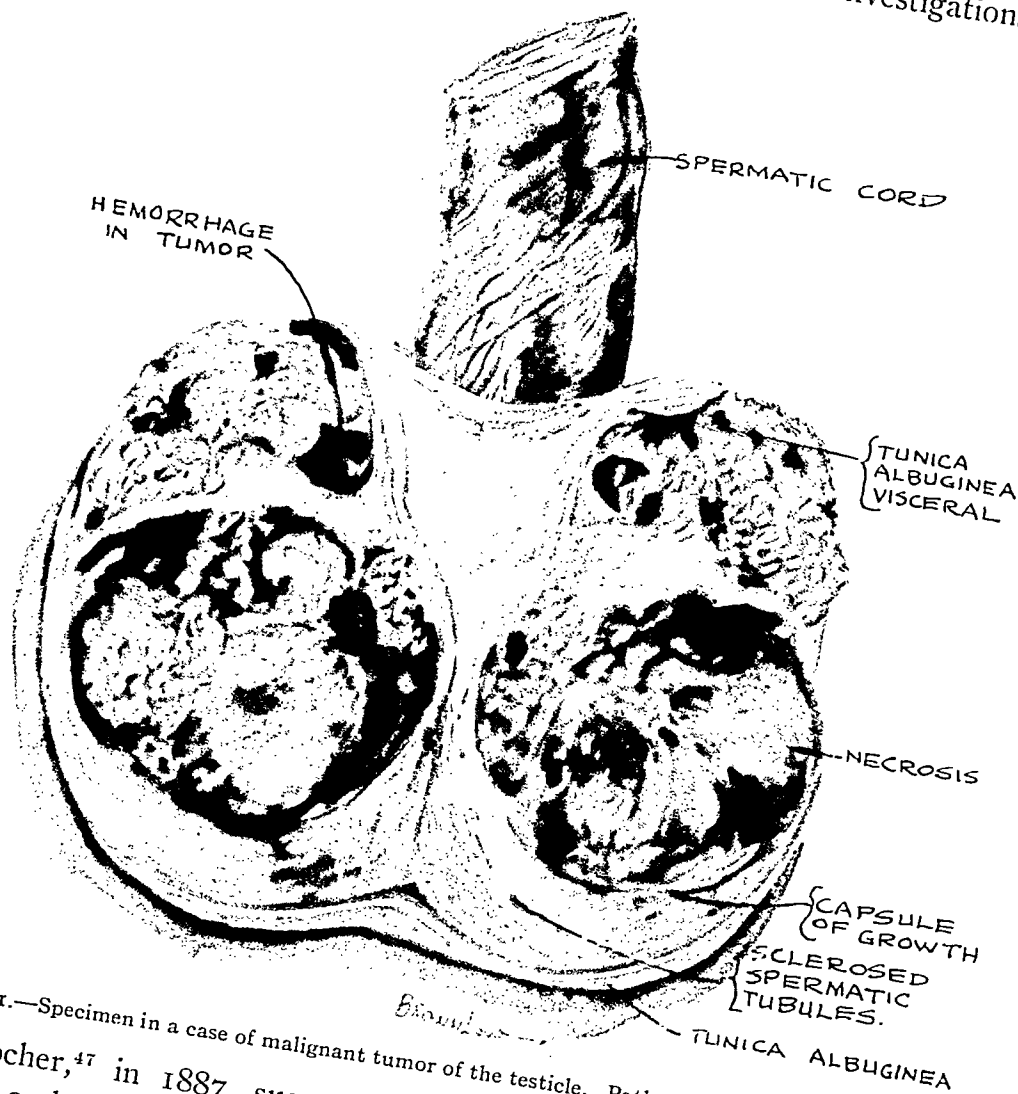


FIG. 1.—Specimen in a case of malignant tumor of the testicle. Pathological diagnosis—teratoma.

and Kocher,<sup>47</sup> in 1887, suggested a histological classification of testicular tumors; and concluded that the majority of these tumors are teratomatous in origin. This conclusion was disputed in 1906 by Chevassu,<sup>15</sup> who stated that the majority of malignant tumors of the testicle were derived from spermatoblasts, and applied to them the term "seminome". In 1911, Ewing<sup>30</sup> carefully reviewed the literature, and after studying

a series of cases, he also concluded that the majority of testicular tumors are of teratomatous origin.

Thus two theories regarding the origin of malignant testicular tumors have prevailed: (1) Kocher's theory that they are of teratomatous origin, which has been upheld by Ewing,<sup>30</sup> Ribbert,<sup>64</sup> Pick,<sup>62</sup> Wilms,<sup>50</sup> O'Crowley and Martland,<sup>57</sup> and Cairns;<sup>14</sup> and (2) the theory that they are deviations from spermatatic tubules, which was advanced by Chevassu and has been supported by Eisendrath,<sup>29</sup> Geist and Thalhimer,<sup>32</sup> Birch-Hirschfeld<sup>8</sup> and others.

Ewing states that the spheroidal tumor, the origin of which has been so strongly contested, is produced by an overgrowth of one element in a pre-existing teratoma. He was unable to find evidence of its origin from the seminiferous tubules.

Eisendrath concludes that while the medullary tumors are primary tumors which arise from the seminiferous tubules, the other tumors of adenomatous character are teratomatous in origin, this being true even in cases in which the heterologous elements cannot be detected.

The term "embryonal carcinoma" has been applied to tumors which are classified as of teratomatous origin because of the presence of heterologous elements, or the occurrence of atypical tissue. (See Fig. 2.) Spermatocytomata are the solid, medullary tumors (of large cell type) derived from the seminiferous tubules.

The following classification by Schultz and Eisendrath<sup>68</sup> seems acceptable:

#### I. *Homologous Tumors.*

##### A. Benign:

###### (1) Epithelial:

(a) Adenoma of the seminal tubules.

###### (2) Mesoblastic:

(a) Fibroma (arising in the tunics).

(b) Leiomyoma (arising in the epididymis).

(c) Vascular tumors.

(d) Interstitial cell tumors.

##### B. Malignant:

###### (1) Epithelial:

(a) Spermatocytoma.

###### (2) Mesoblastic:

(a) Sarcoma.

#### II. *Heterologous Tumors.*

##### A. Benign:

(1) Cystic dermoid.

##### B. Malignant:

(1) Embryonal carcinoma.

(2) Sarcomatous mixed tumor.

*Pathology.*—Most malignant tumors of the testicle may be classified in two groups: teratomata, or mixed tumors, and spheroidal cell tumors. As we now know, sarcomata of the testicle are quite rare.

*Teratomata* comprise over half the malignant tumors of the testicle. They are very malignant and are frequently rapid in growth. In many cases the

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microscopical diagnosis is made with relative ease, but occasionally the overgrowth of one type of tissue completely obscures the other elements. Grossly, the tumors are whitish in color, with areas of necrosis and

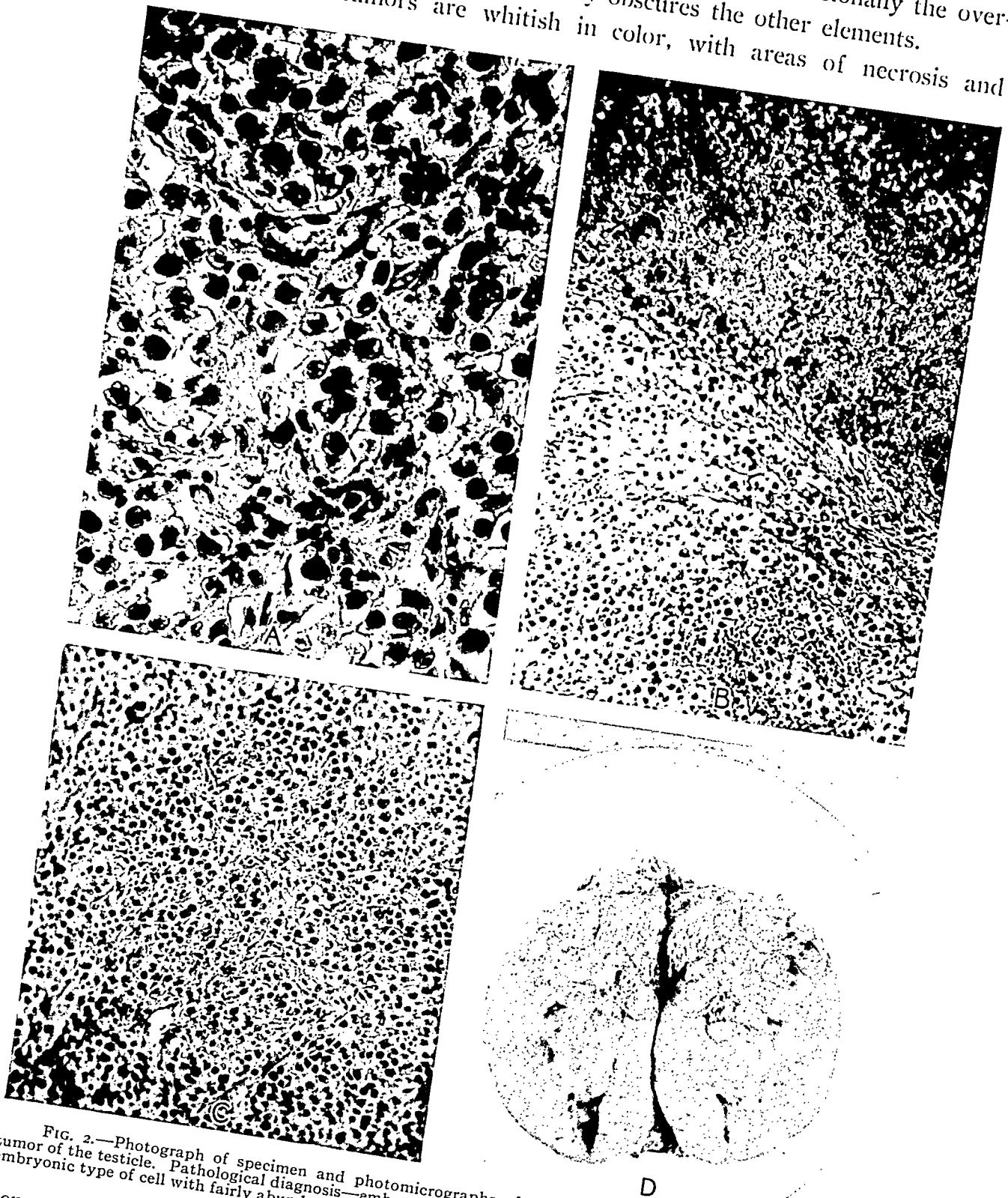


FIG. 2.—Photograph of specimen and photomicrographs of sections made in a case of malignant tumor of the testicle. Pathological diagnosis—embryoma. A—Photomicrograph  $\times 200$ , showing technical embryonic type of cell with fairly abundant cytoplasm; B— $\times 100$ , showing area of necrosis; C— $\times 100$ . hemorrhage. Cartilage and cysts may be present. Microscopically the various tissues are present in different stages of differentiation. The hetero-

logous elements are numerous and in many cases it is impossible to determine the specific germinal layer in which the cells have originated. Cartilage may be present in all the different stages of differentiation up to the point of ossification, and involuntary muscle fibres are also present in various stages of differentiation. Tissue of glandular structure also is usually present. Eisendrath mentions that atypical tissue may have the appearance of chorionic epithelium. Usually, however, the presence of heterologous elements indicates the teratomatous nature of the tumor.

The pathological picture of *spheroidal cell tumors* of the testicle is entirely different from that presented by the teratomata. These tumors are large, firm, and solid, yellowish in color, and medullary in character, and the microscopic appearance of the cells is quite characteristic. The tumors are very cellular with scanty reticulum. The cells are large and contain large vesicular nuclei and a granular cytoplasm. Degenerated areas may also be present, producing small white zones scattered through the tissue. The polyhedral cells are quite characteristic.

In Tanner's<sup>75</sup> report of 97 malignant growths of the testicle, 35 were of the mixed type and 62 of the medullary type. Miyata,<sup>55</sup> in 1913, reported 27 cases of tumor of the testicle, 21 of which were classified as sarcomata, one as a sarcoma in a mixed tumor, one as a perithelioma and three as endotheliomata.

Bulkley<sup>12</sup> collected reports of 59 tumors in undescended testicles and found each to have been a sarcoma of some type except for 19 cases which were classified as follows: two teratomata, two epitheliomata, two chorio-epitheliomata, seven carcinomata, one rhabdomyoma, and five which were simply designated as cancer.

Butt and Arken,<sup>13</sup> in 1914, described a case of bilateral sarcocarcinoma in undescended testicles.

Geist and Thalhimer,<sup>32</sup> in reviewing the histopathology of 26 cases, found 20 cases of carcinoma, of which 16 were medullary and four adenomatous in type, and six cases in which teratoma was associated with carcinoma (adenomatous with medullary or papillary areas).

Eisendrath<sup>20</sup> has reported nine cases of embryonal carcinoma and six cases of spermatocytoma.

It is obvious that the great discrepancy in the incidence of various types of tumor is due in great part to varying methods of classification on the part of the reporters, some authors reporting large series of cases of sarcoma, the histological picture of which is identical with that of the large cell type of medullary tumor.

Of the 23 cases of malignant tumors of the testicle which I am reporting here, five were carcinomata, two sarcomata, five teratomata, and three embryomata, and in eight cases the type was not specified—in four of them no operation was performed.

*Age Incidence.*—The tumors appear most frequently during the age of greatest sexual activity, that is, between the ages of twenty and fifty; however, no age is exempt.

According to Kutzmann and Gibson,<sup>43</sup> tumors of the testes are of comparatively rare occurrence in children. Steffen<sup>72</sup> and Gerhardt<sup>73</sup> state that when tumors of the testis occur in children, it is chiefly in early infancy, generally in the first six months

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or the first year. The incidence then gradually diminishes in the second, third and fourth years and the tumors seldom occur in later childhood. Kober<sup>10</sup> was unable to find any cases between the ages of ten and twelve years. Chevassu<sup>13</sup> found five cases of teratoma in children in a series of 128 teratomata and seminomata. Dean<sup>24</sup> states that the tumors occur usually before the fortieth year. Schultz and Eisendrath<sup>63</sup> described nine cases of embryonal carcinoma in which the average age of the patients was twenty-nine years, and six cases of spermatocytoma, in which the average age of the patients was forty-one years. These authors called attention to the fact that the age incidence of spermatocytoma was higher than that of embryonic

TABLE I.  
*Incidence of Tumors in Undescended Testicles in Relation to Total Series of Testicular Tumors.*  
(After Lipshutz)

Author	Testicular tumors	In undescended testicles			Percentage
		Ing.	Abd.	Total	
1. Howard.....	57	8	1	9	15.8
2. von Kahlden.....	41			5	12.2
3. Chevassu.....	128	10	5	15	11.7
4. Ufferduzzi.....	159			6	3.8
5. Hinman.....	32			7	21.9
6. Cunningham.....	67			0	0
7. Odiorne and Simmons...	54	2	4	6	11.1
8. Coley.....	64			12	18.7
9. Kober.....	114			18	15.8
10. Bulkley.....	9		2	2	22.2
11. Lower*.....	23	1		1	4.3

\*This series.

carcinoma, but the clinical course was shorter and more rapid. Jefferson<sup>41</sup> states that the age incidence of tumors of the testicle lies between twenty and fifty years. In our series of cases the youngest patient was twenty-one years of age and the oldest fifty-three, the average being thirty-four years.

*Frequency and Location.*—Cunningham<sup>22</sup> found that in his series the incidence of new growths in testicles which occupied their normal position was 10.3 per cent. greater than in imperfectly descended testicles. In operations in forty cases of imperfectly descended testicles, Keyes<sup>45</sup> found no evidence of teratomata in any case. He has observed three tumors in testes in the abdomen.

Bulkley<sup>12</sup> states that among 12,729 male admissions to the Presbyterian Hospital in New York, thirteen cases of malignancy of the testicle were observed; and that of this series eleven were scrotal and two abdominal. The incidence of malignant tumors in abdominally retained testes was one in every seventy-five. Among all cases of malignancy in an abnormally located testicle, one in four occurred in the abdominal cavity, while the ratio of malignant growths in abdominal testicles to those in scrotal testes was one to fifteen.

Howard<sup>42</sup> states that among 110,000 male admissions there were sixty-five cases

of testicular malignancy, and that fifty-six of these were scrotal and nine inguinal, there being no abdominal tumors in this series.

Eccles<sup>27</sup> found thirty-eight testicular malignancies among 60,000 male admissions. In this series only one tumor occurred in an undescended testicle. Tanner<sup>28</sup> states that one in every 2000 male admissions shows malignancy of the testicle.

In our series only one case (Case 22) occurred in an undescended testicle. (See Tables I and II.)

Reports in the literature vary as to the predominance of tumors in the right or left testicle, and many authors note no difference in the incidence

TABLE II.  
*Incidence of Testicular Tumors in Undescended Testicles.*  
(After Kutzmann and Gibson)

Author	Number of cases of undescended testicle	Number of testicular tumors	Percentage
Eccles.....	859	0	0
Coley.....	1357	0	0
Kocher.....	1000	1	0.1
Brenner.....	75	0	0
Hoffstatter.....	181	4	2.2
Goeritz.....	57	1	1.7
Total.....	3539	6	0.17

in this respect. In Cunningham's<sup>22</sup> series thirty-four of the tumors were found to involve the right testicle, 25 the left, and three were bilateral. In our series, 14 tumors involved the right and 9 the left testicle.

Bilateral malignant tumors of the testicle are rare. Chevassu<sup>15</sup> noted one case among 128; Kober,<sup>46</sup> five among 93 cases; and Cunningham,<sup>22</sup> three among 67 cases. Councilman and Lovett<sup>20</sup> reported one case of bilateral teratoma of the testicles and Ochsner<sup>56</sup> also reported one such case. Our series of cases includes one bilateral case which will be reported in a later communication.

*Etiology.*—In many cases the patient gives a history of trauma, but this is frequently merely the incident that causes the patient to note an enlargement which is already present. In Cairn's<sup>14</sup> series fourteen of the seventy-nine patients had observed the enlargement after a trauma of the testicle. Among the reports cited by Tanner,<sup>75</sup> in twenty-two of a series of 100 cases the patients gave a history of trauma. Pohle<sup>63</sup> states that trauma appeared to be an etiological factor in a few of his cases. Some reports give a history of trauma in 50 per cent. of the cases. Among the cases in our series, only four of the patients gave a history of trauma, and in two of these the accident had occurred many years before the development of the tumor.

In spite of the cases in which there has been a history of trauma, however, it is very doubtful whether trauma alone gives rise to the neoplastic

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process. We know that constant and prolonged irritation may promote the production of a malignant growth. The presence of a preëxisting tumor of the testicle cannot be excluded as a possible cause and such a tumor may be stimulated by trauma to more rapid growth. In the same manner constant pressure and irritation may exert a similar influence upon an undescended testicle lying in the inguinal canal.

*Symptomatology and Diagnosis.*—There are no pathognomonic signs or symptoms of a malignant tumor of the testicle. In fact, the diagnosis is occasionally reached by a process of exclusion. Pain and tenderness are present in many cases but are strikingly absent in others. In Tanner's<sup>75</sup> series, 52 per cent. of the patients complained of pain, while among Dean's<sup>21</sup> cases only a few patients made this complaint. In the latter series, 8 per cent. of the patients had abdominal pain, 29 per cent. had a lumbar ache, and 5 per cent. had abdominal cramps. In many cases the patients give a history of progressive enlargement of the testicle, with no pain until metastasis is present. Weakness and loss of appetite are also late manifestations.

In our series the subjective symptoms were testicular pain in four cases, or 17.4 per cent., more or less constant lumbar pain which was increased by movement in seven cases, or 30.4 per cent., loss of weight in six cases, or 26 per cent., and loss of appetite in three, or 13 per cent.

On reviewing the symptoms which were present in our cases when they were first examined, I found that before the primary operation, testicular pain had occurred in four cases, pain in the back in three, loss of weight in four, and loss of appetite in one case. As for the symptoms of the patients when they came to us at varying periods after operation—those in Group IV, pain in the back occurred in three cases and loss of weight in three.

In making a differential diagnosis hydrocele, hæmatocele, gumma and tuberculosis must be considered.

A careful investigation of the personal and familial histories of the patient is of value in eliminating *tuberculosis*. The first evidence of the presence of a pathological condition of the testicle which is due to tuberculosis occurs in the epididymis and thence extends along the vas, which becomes nodular, the testicle becoming involved later. If the lesion extends to the skin of the scrotum, persistent sinus formation follows. Rectal examination of the seminal vesicles and prostate may demonstrate a tuberculous involvement. A röntgenogram of the lungs may also demonstrate the presence of an active tuberculous lesion. As for the clinical course of tuberculosis, it may be more rapid than that of a malignant growth, pain is more frequently present, and an elevation of temperature may be noted.

It must always be remembered that *hydrocele* and a malignant tumor of the testicle may coexist. This combination of diseases was found in two cases of this series. Transillumination should always be employed in making a diagnosis of hydrocele. The testicle should be carefully examined during operation to determine whether or not hydrocele is present; or if a hydrocele

is tapped, the testicle should be carefully palpated after the tapping to determine the presence or absence of a tumor.

In eliminating *hæmatocele* it is important to learn whether or not there is a history of trauma. An *hæmatocele* is usually a uniform swelling, and when it is present it may not be possible to transilluminate the scrotum or to produce fluctuation. French observers emphasize particularly that when this

condition is present the head of the epididymis cannot be palpated, but as it may also be involved by a tumor of the testicle or compressed by a large growth, this finding seems of little value from a diagnostic standpoint.

The diagnostic ability of the surgeon will be taxed to the utmost to differentiate an *hæmatocele* of long duration in which solidification and calcification have taken place from a malignant tumor of the testicle. Tanner<sup>75</sup> states that the tunica vaginalis can be palpated on the surface of a scrotal tumor and that this is not true in a case of *hæmatocele*, in



FIG. 3.—Röntgenogram showing evidence of metastasis in the mediastinum in a case of malignant tumor of the testicle. (Case XVI.)

which also the epididymis cannot be felt between the fingers, as it is hidden within the *hæmatocele*.

In differentiation of a malignant tumor from a gumma careful questioning may elicit the history of the former presence of a primary luetic lesion. A Wassermann test is indicated in all cases of testicular tumor. If doubt as to the character of the tumor persists, then the administration of potassium iodid and of mercury may establish the diagnosis, as they will cause a gumma to decrease in size in from seven to ten days. It should be borne in mind, however, that syphilis and a malignant tumor of the testicle may coexist, so that undue dependence must not be placed upon a positive Wassermann reaction in a case in which the tumor does not respond to anti-syphilitic therapy.

In its early stages a malignant tumor of the testicle is firm and smooth



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and causes no change in the contour of the testicle, although nodulation may occur later. Palpation may produce pain or elicit tenderness, but this is not a constant finding. The epididymis is usually palpable and is clinically free from change. If necrosis has taken place in the tumor, fluctuation may be noted. The skin is usually uninvolved and moves freely over the testicle. The testicle cannot be transilluminated. Occasionally, on account of the need for an increased blood supply, the cord may be enlarged. An examination to determine the presence of glandular adenopathy in the left supraclavicular fossa and in the inguinal regions may be of value.

In differentiating malignant from benign tumors of the testicle, it should be remembered that the latter are quite rare in occurrence. However, the following benign tumors do occur: adenomata arising from the seminal tubules; fibromata arising from the tunica, leiomyomata arising from the epididymis, vascular tumors, interstitial cell tumors and dermoids. According to Cairns,<sup>14</sup> only forty-

seven undoubted cases of dermoid of the testicle in man have been reported, 62 per cent. having been observed shortly after birth, and 84 per cent. in the first year of life. Only five of the forty-four were cases first observed after the patient had reached adult years. It is interesting to note that dermoid tumors associated with cryptorchism are occasionally found in the horse. (Hobday.)

The diagnosis of malignancy of an abdominal testicle cannot be made with certainty until a palpable mass is present. Changes in the breast and in the distribution of the hair have been cited, but these signs usually are absent. If pressure symptoms occur, such as lumbar pain, shooting pains down the legs, pressure on the rectum, and cedema of the legs, and the testicle



FIG. 4.—Röntgenogram showing evidence of metastasis in the mediastinum in a case of malignant tumor of the testicle. (Case XXII.)

TABLE III.  
Data in Nine Cases of Malignant Tumor of the Testicle in Which Primary Treatment Was Given.

Case	Date of examination	Symptoms	Duration of symptoms	History of trauma	Age	Side	Clinical evidence of metastasis	Operation and date	Pathological diagnosis	X-ray therapy	Period between operation and death	Period between operation and last observation (in living cases)	Evidence of metastasis at last observation
1	11-9-20	Testicle eight times natural size, firm			45	L		Orchidectomy 11-9-20	Carcinoma			6 yrs. 8 mos.	None.
2	12-1-21	Testicle size of grape-fruit. No pain. Loss of 10 pounds during 4 months	4 mos.	20 yrs. before, caused slight enlargement	39	R		Orchidectomy 12-2-21	Undifferentiated malignant teratoma		1 yr. 9 mos.		
3	1-14-22	Very large testicle, growing rapidly. Very tender, sensation of heaviness. No pain. Hard and firm	2½ mos.		29	L		Orchidectomy and bilateral herniorrhaphy 1-20-22	Undifferentiated teratoma			5 yrs. 2 mos.	None.
4	3-6-25	Enlarged testicle. No pain. Superficial veins prominent	1 mo.		26	L	Epitrochlear, axillary and inguinal glands enlarged	Orchidectomy 3-10-25	Embryoma	Post-operative		2 yrs. 3 mos.	None.
5	9-21-25	Testicle size of goose egg, firm and hard	3 yrs.		38	R	Inguinal glands slightly enlarged	Orchidectomy 10-29-25	Embryonal carcinoma	Pre-operative		1 yr. 5 mos.	
6	12-3-25	Testicle size of goose egg, hard, smooth, tense; very little pain	3 mos.	3 mos.	43	R	Inguinal glands shotty	Orchidectomy 12-29-25	Teratoma	Post-operative For metastasis in abdomen February, 1927		1 yr. 5 mos.	Small mass below umbilicus not enlarging.
7	1-16-26	Constant, severe pain in right groin, hip and testicle. Testicle slightly enlarged, hard, tense, tender. Epididymis tender to pressure, with uneven masses size of pea	3 wks.		31	R		Orchidectomy 2-25-26	Teratoma			5 mos.	Large, hard tumor in upper right quadrant of abdomen.
8	4-6-27	Operation for hydrocele 20 years before. Testicle enlarged to size of grape-fruit following strain; tense and hard, lower portion fluctuant	1 yr.	1 yr. (strain)	53	L		Orchidectomy 4-7-27	Embryonal carcinoma				
9	4-14-27	Testicle size of goose egg, firm. No pain. Scrotum blue	2 mos.		27	R		Orchidectomy 6-1-27	Embryoma	Post-operative			

## MALIGNANT TUMORS OF THE TESTICLE

is absent from the scrotum or inguinal canal, the possibility of malignant tumor in an undescended abdominal testicle should always be considered.

In cases in which a testicle located in the inguinal canal enlarges progressively, the possibility of malignancy should also be considered and surgery recommended.

*Time Elapsing Before a Physician is Consulted.*—In many cases, because of the slow development of the swelling and the absence of pain, the patients do not consult a physician until metastases are present. In our series the average length of time which elapsed between the discovery of the swelling of the testicle and consultation was ten months.

*Clinical Evidence of Metastasis.*—In many cases abdominal masses and evidence of inguinal adenopathy are present and also presumptive signs of metastasis such as lumbar pain, pain radiating down the leg, and oedema. Among the fourteen patients who came to us for primary examination and treatment eight showed no clinical evidence of metastasis. Among the other six cases there were metastases: in the abdomen, in one case; in the inguinal glands, in two cases; in the inguinal, axillary and epitrochlear glands, in one case; in the abdomen and supraclavicular glands in one case.

In the cases not included in the above list the patients had been operated upon or examined elsewhere previously, and came to us for X-ray therapy. Evidence of metastasis was present in each of these cases. Figs. 3 and 4 show röntgenological evidence of mediastinal metastases in two of the cases (Cases 16, 22) and Fig. 5 shows tumor masses in the supraclavicular region and in the lower abdomen.

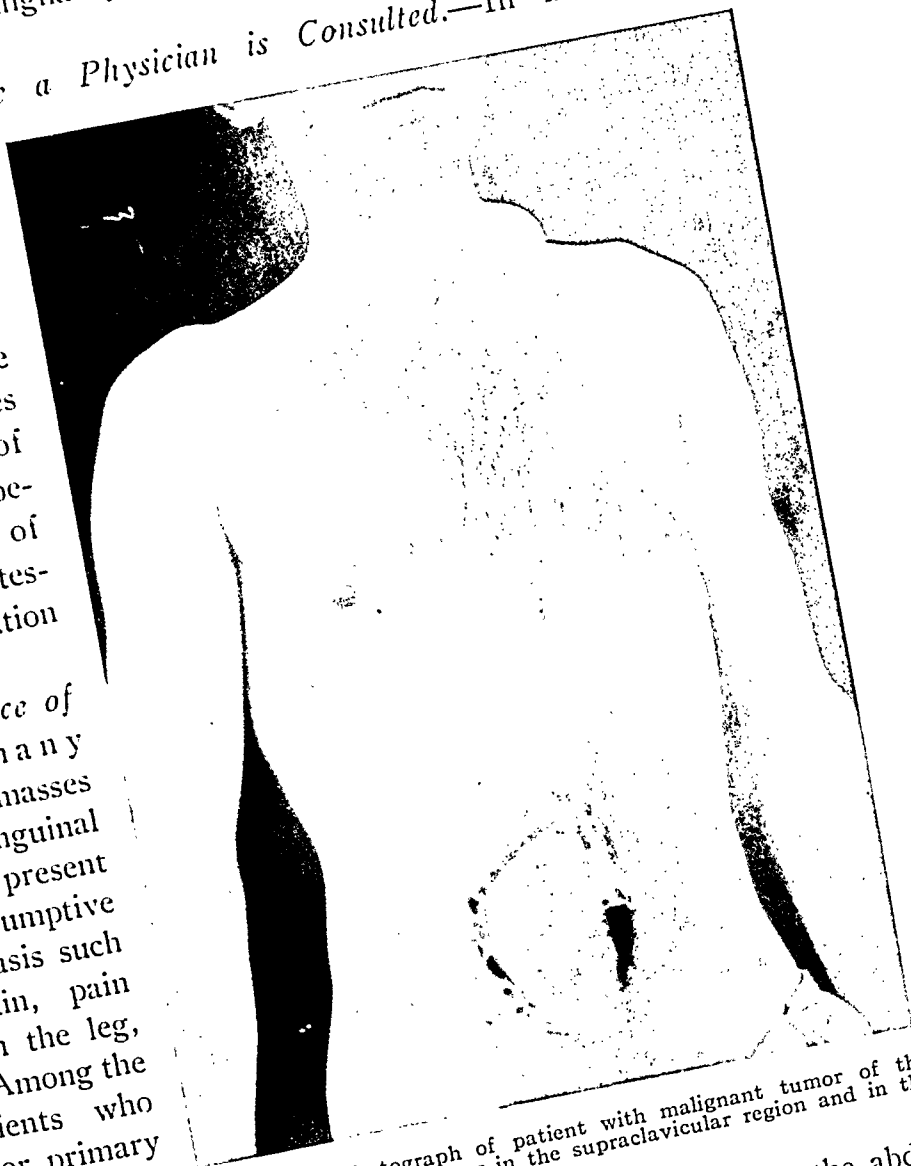


FIG. 5.—Photograph of patient with malignant tumor of the testicle. Note the tumors in the supraclavicular region and in the lower abdomen. (Case XXI.)

*Mode of Extension and the Lymphatic System.*—The lymphatic extension of the testicles is described by Leidy<sup>49</sup> and by Delamere, Poirier and Cuneo,<sup>23</sup> as follows:

“The lymphatics of the testicle are numerous and chiefly commence in the lymph-spaces in the intervals of the seminiferous tubules. From finer plexuses in the vascular tunic and epididymis a half dozen large trunks pursue the course of the spermatic veins and terminate in the lumbar lymphatic glands.

“The lymphatics of the testicle unite with the lymphatics of the epididymis, and the visceral layer of the tunica vaginalis, and run toward the lumbar region along the

TABLE IV.

*Data in Two Cases in Which Operation was Advised But Refused.*

Case	Date of examination	Symptoms	Duration of symptoms	Age	Side	Operation and date	Period between examination and death
10	6-5-22	Testicle enlarging progressively, size of orange, very hard. Enlargement along vas nearly to symphysis. No pain	3 mos.	34	R	Operation advised but refused	11 mos.
11	11-10-22	Pain in back and hip. Testicle enlarged, very firm, nodular		32	R	Operation advised but refused	5 mos.

spermatic cord. They are usually more superficial than the blood-vessels with which they are in immediate contact . . . In the lumbar region these trunks leave the spermatic vessels and run toward their terminal glands . . . The trunks coming from the right testicle terminate at the right juxta-aortic glands . . .

“The trunks of the left side end in the three or four glands of the left juxta-aortic group, which are arranged in rows below the renal vessels, but here again, we may sometimes see that some lymphatics are not arrested in the glands of this group, but directly reach the preaortic glands.” (Delamere, *et al.*)

“The spermatic artery, a long, narrow vessel, springs from the aorta below the renal artery, descends along the psoas muscle, crosses the ureter and external iliac blood-vessels, and enters the internal abdominal ring, where it joins the spermatic cord and descends in advance of the deferent canal to the testicle. Approaching the latter it gives off a smaller branch to the epididymis, while the larger one divides into others which penetrate the albuginea along the back of the testicle and enter the mediastinum, whence they are distributed in the vascular tunic, partly on the inner surface of the albuginea and partly along the septula between the lobes of the testicle.

“A long thread-like vessel, the deferent artery, comes from one of the vesical arteries and runs upon the deferent canal its entire length, supplying it in its course and terminating by anastomosing with the branch of the spermatic artery distributed to the epididymis.

“The spermatic veins, passing from the vascular tunic of the testicle, emerge from the albuginea in a number of branches along the back of the testicle, where they are joined by others from the epididymis. The veins ascend in company with the spermatic artery in the fore part of the cord and anastomose with one another, forming a plexus. From this, two or three veins enter the abdomen and unite in a single trunk, which follows the course of the spermatic artery; that of the right side terminating in the inferior cava and that of the left side in the corresponding vein.” (Leidy.)

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*Treatment.*—Many types of treatment for malignant growths of the testicle have been attempted: orchidectomy followed by X-ray, by radium packs, and by Coley's serum; orchidectomy followed by a radical resection of the gland; X-ray alone; and radium alone.

*Coley's Serum.*—Coley<sup>38</sup> states that the serum which he uses in the treatment of these tumors has an inhibitory action on the growth of the tumor cells. In some cases the action is sufficiently striking to prevent further development of the tumor, in other cases the growth may be held in check for a long period of time, while in some cases recurrences disappear following the administration of the toxin but usually reappear later.

Coley recommends orchidectomy as the primary treatment, this being followed by diligent and persevering administration of the toxin. The application of massive doses of radium to the abdomen and to the supraclavicular region is also advocated. The toxin is administered in the following manner: The injections are given deep into the buttocks, starting with a dose of one-half minim, and increasing daily by one-half minim until a mild reaction occurs, the temperature ranging from 100° to 102°. The toxin is then given three times weekly, the dosage being again increased until a mild reaction occurs. At the end of three months the injections are given twice a week. The treatment with X-ray and radium is repeated in from four to six months.

Pohle<sup>39</sup> also advises radiation with the Röntgen-ray or with radium. He states, however, that a favorable influence may be exerted by radiation, but a cure seldom results.

Dean<sup>24</sup> recommends, first, the application of low voltage X-ray to the testes, and of high voltage to the pelvis and lumbar nodes on the same side as the testicular lesion, followed, after three weeks, by an orchidectomy. He does not advise the radical removal of the glands. Two months after the first irradiation a radiation of the same intensity is again applied over the same areas and the patient is told to report at intervals for observation.

French authors advocate radiotherapy on the ground that seminomes are derived from spermatoblasts. Levin<sup>30</sup> also states that the specific action of radium on testicular cells accounts for its effect on malignant tumors of the testicle, the action of the rays being confined to destruction of the spermatogenic elements; however, injury of the other tissues is not evident.

As a result of their investigations, Barringer and Dean<sup>24</sup> concluded that the embryonal type of tumor which they classify according to Ewing,<sup>30</sup> reacts best to treatment. This is opposed to the opinion of French observers as, according to Ewing, the seminome belongs in the same class as the teratoma of embryonic type (embryonal carcinoma).

Jefferson<sup>43</sup> recommends orchidectomy with high excision of the cord.

In 1882, Kocher<sup>47</sup> attempted the transperitoneal resection of the lumbar glands and this operation was repeated by Bland-Sutton<sup>9</sup> in 1895 and later by Villar. Hinman<sup>39</sup> has collected seventy-nine cases, ten of his own series, in which radical operation was performed. Roberts, of Philadelphia, was the first to remove nodes which were uninvolved clinically (1901).

In determining the advisability of performing the radical operation for tumors of the testicle one point must be emphasized—the radical operation should not be attempted if the enlargement of the glands can be recognized clinically. X-ray therapy is preferable in these cases. When the glands are palpable they are enlarged to such an extent that their removal is impossible. According to Kutzmann and Gibson,<sup>48</sup> in only 50 per cent. of the cases are the glands removable after they become involved.

Another important point is that a microscopical report on the removed



# MALIGNANT TUMORS OF THE TESTICLE

glands and lymphatics can then be carried on from above downward or from below upward. We prefer the latter method. The cord and vessels are stripped upward, toward the lumbar region. The glands and lymphatic-bearing tissue are carefully removed from the iliac fossa, care being taken to avoid injury to the ureter, which usually remains attached to the peritoneum and is reflected forward with it. The point at which the ureter crosses the iliac vessels is carefully exposed. Metastasis frequently occurs at this point, and also at the bifurcation of the aorta. The spermatic artery is clamped where it branches off from the aorta, and the spermatic vein, as it enters the renal vein or the inferior mesenteric vein.

The vas deferens is divided as it leaves the internal ring. The dissection is then carried upward along the anterior surface of the aorta, the lymphatic tissue being removed. Care must be taken to avoid injury to the inferior mesenteric artery. Since the spermatic vessels spread out above the point of ligation of the vas, the fascia is dissected to the lateral border of the psoas muscle. If the tumor involves the right testicle the vena cava

must be carefully stripped. The dissection is then carefully carried upward to the kidney. The fascia of the iliac and of the psoas muscle must be completely removed, as must also the inguinal glands on the side on which the tumor occurs.

Sharp dissection is the preferred method, as a more exacting and complete removal of the glands and lymphatics is secured in this way and less trauma is instituted. The operation is very extensive and is performed in a field in which vital structures are present. As the result of the division of the tenth, eleventh, and twelfth dorsal nerves, post-operative hernia may occur.



FIG. 7.—Drawing to show completion of the operation. The spermatic vessels at their point of junction with the abdominal vein and artery have been isolated, ligated, and divided before resection is attempted, which may then be carried out from above downward or from below upward. (Reproduced through the courtesy of Dr. Frank Hinman.)

TABLE V.  
*Data in Three Inoperable Cases.*

Case	Date of examination	Symptoms	Duration of symptoms	Age	Side	Clinical evidence of metastasis	Operation and date	Pathological diagnosis	X-ray therapy	Period between examination and death	Period between examination and last observation (in living cases)	Evidence of metastasis at last observation
12	7-30-24	Testicle size of tennis ball, hard, firm. Not painful. Hard, nodular mass in left hypochondrium. Loss of 18 pounds. Fever, loss of appetite, pain in abdomen, constipation	3 yrs.	39	L	In abdomen at first examination. 9-9-25. In mediastinum 12-5-26. In spinal cord (VI D-segment)			7-31-24 9- 9-25 1- 1-26 1-23-26 5-16-27		3 yrs.	Yes.
13	5-14-25	Testicle swollen, hard, firm. Severe pain in lumbar region and abdomen	1 mo.	40	L	Masses in abdomen and supraclavicular area	Exploratory laparotomy; excision specimen	Teratoma	Pre-operative	4 mos.		
14	5-5-27	Testicle enlarged, smooth, fluid in scrotum. Slight pain radiating down legs	2 yrs.	39	L	Large fixed mass in abdomen			X-ray therapy advised			



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*Prognosis.*—Whatever type of treatment is employed, whether surgical or X-ray, the prognosis in cases of malignant tumor of the testicle is grave. Metastasis occurs early and may be present even when no clinical evidence of it is demonstrable and while the tumor of the testicle is still relatively small. When they are demonstrable clinically, the metastases are usually so extensive that a cure cannot be secured. However, by radium, X-ray, and Coley's serum, the course of the disease may be abated and a decrease in the size of the metastatic lesion may be secured.

According to Tanner,<sup>75</sup> the prognosis is influenced by the pathology of the tumor, mixed tumors being very malignant, carcinomatous tumors being malignant to a lesser degree, and dermoids being benign. Other observers agree with these conclusions, and our own results seem to confirm them, as in one of the cases of this series in which the tumor was a carcinoma, the patient is alive and free from metastases approximately six and one-half years after treatment.

*Operative Mortality.*—The operative mortality for orchidectomy is nil. The operative mortality for the radical operation varies from 10 to 20 per cent. This high mortality is explained by the fact that the patient frequently is not in good condition and the radical operation is very extensive.

*Results of Treatment.*—The results reported by various authors indicate that in cases of malignant tumor of the testicle the prognosis is grave. It is stated that 30 per cent. of the cases treated by radical operation are cured; while of the cases treated by orchidectomy only 15 per cent. are cured, these cases being the ones in which treatment is given early, before metastases have occurred.

In a review of seventy-nine cases—including ten personal cases—in which the radical operation was performed, Hinman<sup>39</sup> has reported that thirty-four of the patients were living and well, six of them over four years after treatment.

Barringer and Dean<sup>4</sup> also have reported their results from the use of radium, which were not encouraging from a prognostic standpoint.

Codman<sup>16</sup> has reported nine cases in which X-ray therapy was administered both before and after operation. In eight of them there were clinical evidences of metastasis when the X-ray treatment was instituted. Of these patients six had died and three were living, twenty-four, twenty-five and thirty months, respectively, after treatment.

In 1906, Cuneo<sup>21</sup> performed the radical operation in one case and the patient was living and well three years later.

Kober<sup>40</sup> has reported ten cases in children, in four of which the patients died within one year after operation, while one patient was living two months after operation with a metastasis in the groin. In the other five cases no information as to the end-results was available.

Steffen<sup>72</sup> has reported twenty-five cases, in thirteen of which the patients died from recurrence or metastasis within eleven months after operation. Of the seven who were living, three had recurrences, but two were living and well eleven months after operation; the condition of the other two living patients was not stated.

Chevassu<sup>25</sup> has reported that among five cases of teratoma in children, four were living and well five months, two years and six months, two years and seven months, three years and eight months, respectively, after operation; the fifth case was not traced.

In a series of forty-four cases collected from the literature by Hinman, 41 per cent. died of cancer; all except two within one year after operation. Of these forty-four

TABLE VI.  
Data In Nine Cases In Which Orchidectomy Had Been Performed Before Our Examination.

Case	Date of our examination	Symptoms at time of our examination	Duration of symptoms	Symptoms at time of operation	Duration of symptoms	History of trauma	Age at time of operation	Side	Clinical evidence of metastasis at time of operation	Operation and date	Pathological diagnosis	X-ray therapy	Period between operation and death	Period between operation and last observation (in living cases)
15	8-25-22	Broken-down glands in left inguinal region; enlarged glands in right inguinal region. Marked oedema of left leg. Loss of 15 pounds		Swelling of testicle			31	L		Testicle incised in 1918, drained one year. Orchidectomy in 1919; cord removed, gland in left inguinal region removed	Sarcoma (clinical)	For metastasis	Date unknown	
16	9-2-25	Right and left inguinal glands enlarged; large gland in right groin; large mass in left side of abdomen. X-ray of chest revealed extensive metastases. Marked loss of weight. Severe pain in back and down right leg	6 mos.	Swelling of testicle			34	R		Orchidectomy—1921. Excision of gland in right groin, March, 1925	Carcinoma	No treatment advised	4 years after primary operation.	
17	6-11-23	Irregular, hard nodular growth along spermatic cord. Swelling size of hen's egg in groin, with ulcerating skin		Painful lump in testicle which grew rapidly for 2 months before operation. Loss of weight	1 yr.	In youth	32	L		Orchidectomy 3-15-23	Spindle cell sarcoma	Post-operative X-ray and radium. X-ray recommended for metastasis		

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18 7-9-24	Enlarged glands in right groin. Sinus from scar in scrotum discharging bloody pus. Right inguinal region slightly painful and swollen	Enlarged testicle, not painful	23	Orchidectomy 11-16-23. Recurrence excised 6-12-24	Sarcoma (clinical)	Post-operative. Advised for metastasis	
19 3-30-25	Swelling size of grapefruit in abdomen below umbilicus, hard, firm, increasing in size. Pain in back, down legs, in upper portion of right thigh. Right leg badly swollen and oedematous	Testicle size of egg, painful and tender	37	Orchidectomy March, 1924	Sarcoma	Post-operative. For metastasis	1 yr. 3 mos.
20 12-11-24	Pain and swelling in right inguinal region. Pain in right shoulder and elbow. Hard, enlarged, tender glands in right inguinal region	Undescended testicle gradually enlarging very painful. Hernia	49	Orchidectomy September, 1924. Excision specimen of groin, 12-12-24	Embryonal carcinoma	No treatment advised	6 mos.
21 3-5-25	Large mass in lower abdomen. Nodule size of egg in left side of neck. Recurrence in scar. Severe pain in back. Marked loss of weight. Patient anemic and cachectic	Testicle size of pear. Painful just before operation. Loss of 50 pounds in 4 months	24	Orchidectomy 10-29-24	Teratoma (clinical)	Advised for metastasis	Date unknown
22 3-25-25	A few hard, shotty glands in groin 10-21-25 Metastasis in mediastinum 11-2-25 Multiple nodules	21	R	Orchidectomy 3-11-25	Embryoma	Post-operative. For metastasis	11 mos.
23 8-24-26	Intermittent swelling over area treated by X-ray	32	R	Orchidectomy November, 1925	Teratoma (clinical)	14 post-operative treatments. 12 treatments administered.	1 yr., 6 mos.

cases, in two the lumbar glands were palpable before operation, while enlarged glands were found at operation in over 50 per cent. of the total series. The longest period that any of these patients had remained free from recurrence was four years and ten months.

Hinman also traced twenty-four cases in a series of thirty-two and found twenty dead and four living.

Tanner<sup>25</sup> collected 600 cases from the literature, of which the post-operative course had been followed in 465. Of these, 377, or 81 per cent., were dead and twenty-five, or 5.5 per cent., were alive and well four years after operation.

In reporting the results of treatment with radium and X-ray in his series of sixty-three cases, Dean<sup>24</sup> has divided the cases into various groups: Among the six cases which he designated as "primary operable", four of the patients were living and well for periods ranging from one year and one month to three years and nine months after treatment, one was dead, and one could not be traced. Among the ten cases in the "primary inoperable" group, two patients were living and well six months, and three years and one month, respectively, after the first irradiation. Among the eight patients who had died the average duration of life after treatment had been fifteen months. One case was called "recurrent operable", but irradiation was employed instead of operation and the patient was free from disease nine months later. Thirty-nine of the patients were classed as "recurrent inoperable", and of these eight had remained living and well for periods of from six months to seven years and seven months, twenty-four were known to be dead, and seven could not be traced. Seven patients were referred for irradiation as a prophylactic measure after removal of the tumor. Of these three were living and well more than two years after treatment, three had died from metastases, and one patient could not be traced.

In 1915, Coley<sup>28</sup> reported fifty-two cases in which the patients had been treated by orchidectomy and serum. Of these only two showed involvement of the lumbar nodes at operation. Of the remaining fifty patients, eighteen had died, fourteen had not been traced, and eighteen were living—three, four years; three, three years; one, two years; and two, one year after orchidectomy. Of the eighteen who were living, nine had metastases.

Gross has reported twenty-six cases, in three of which the patients had remained well, two for two years, and one for fourteen years after treatment.

Hinman collected forty-six cases in which the radical operation had been performed. The combined mortality was eleven per cent. Of the twenty patients who were still living, one had lived for five years, one for four years; five for three years, two for two years, and eleven for one year.

Of the twenty-three cases in our series, in sixteen there was no evidence of metastasis before operation. The end results in these cases is as follows: Six patients are living and eight have died and two have not been traced. Of the six living patients, two were seen too recently for any report regarding them to be of value; three are living without metastasis, six years and eight months, five years and two months and one year and six months after operation; one is living with metastasis five months after operation. Of the eight patients in this group who have died, one lived for four years, two more than one year, one eleven months, and one six months after operation; the date of the death of one patient is unknown; two refused treatment, one dying eleven months and one five months later.

In seven cases in our total series clinical evidence of metastasis was presented. Of these, two patients are living without metastasis two years and three months, and one year and five months, respectively, after operation;

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two patients are living with metastases, one, one year and five months after operation, one—an inoperable case—three years after treatment; two have died, one—an inoperable case—four months after X-ray treatment; one at an unknown date after operation; one case was seen too recently to be included in this report.

### SUMMARIES OF CASE REPORTS

GROUP I.—*Nine cases in which primary treatment was given.*

CASE I.—On November 9, 1920, a patient forty-five years of age, entered the hospital, complaining of an enlargement of the left testicle. The testicle was found to be about eight times the natural size and firm.

*Treatment.*—Orchidectomy.

*Pathological Diagnosis.*—Carcinoma.

The patient was last heard from on March 25, 1927, when he reported that his condition was good, and that there was no evidence of any metastasis.

CASE II.—On December 1, 1921, a patient thirty-nine years of age entered the Clinic, complaining of an enlarged right testicle. About twenty years before he had been kicked by a horse in the right testicle, which had been slightly enlarged ever since, but had not been painful. About four months before, the right testicle had again begun to enlarge, and at the time of the examination it was about the size of a grape fruit. The enlargement caused no pain but interfered with walking. There was no tenderness. The patient had lost ten pounds during the preceding four months.

Examination revealed a poorly nourished, emaciated man, with the right testis greatly enlarged. It was not tender to the touch and was freely movable in the scrotum. There was no evidence of metastasis. The Wassermann test was negative.

*Treatment.*—Orchidectomy. A slight hydrocele was discovered, as well as the tumor.

*Pathological Diagnosis.*—Undifferentiated malignant teratoma.

The patient remained well over a year, but died September 11, 1923.

CASE III.—On January 14, 1922, a patient twenty-nine years of age entered the Clinic, complaining of enlargement of the left testicle. Six years before, bilateral inguinal herniæ had developed and the patient had been wearing a truss. About two and a half months before, the patient had noticed a sensation of pricking in the left testicle and had discovered that it was greatly enlarged. According to his story, it had increased greatly in size "overnight". At first it was tender to pressure but later it grew hard and was no longer tender.

Examination showed the left testicle to be markedly enlarged, hard and firm, but not tender. The epididymis appeared to be normal. There was no involvement of the cord. The Wassermann test was negative. Laboratory examination gave normal findings.

*Treatment.*—Orchidectomy and bilateral herniorrhaphy.

*Pathological Diagnosis.*—Undifferentiated teratoma.

When the patient was last seen, on March 25, 1927, his condition was good and there was no evidence of metastasis.

CASE IV.—On March 6, 1925, a patient twenty-six years of age entered the Clinic, complaining of a swollen left testicle. About one month before he had noticed that the left testicle which had previously been smaller than the right, was enlarging quite rapidly. There was no pain and no history of trauma.

Examination showed the right testicle to be normal, the left testicle symmetrically enlarged, and the superficial veins pronounced. It could not be transilluminated. The testicle was not tender. There were no nodules and the swelling did not involve the cord. The epitrochlear, axillary, and inguinal glands were enlarged.

*Treatment.*—Orchidectomy and X-ray therapy.

*Pathological Diagnosis.*—Embryoma.

When the patient was last seen, on June 10, 1927, his condition was excellent and there was no evidence of metastasis.

CASE V.—On September 21, 1925, a patient thirty-eight years of age entered the Clinic, complaining of an enlarged right testicle. This testicle had always been smaller than the left until three years before, but it had been gradually increasing in size since that time, especially recently.

Examination revealed a large right testicle, of the size of a goose egg. It could not be transilluminated. The testicle was firm and hard, especially at the upper pole. There were no nodules and no tenderness. The process did not extend up the cord. The inguinal glands were slightly enlarged.

*Treatment.*—X-ray therapy followed by orchidectomy.

*Pathological Report.*—Embryonal carcinoma. (See Fig. 2.)

When the patient was last seen, on March 25, 1927, his condition was good.

CASE VI.—On December 3, 1925, a patient forty-three years of age entered the Clinic, complaining of an enlargement of the right testicle. Three months before he had injured the testicle and had had severe pain. It had been treated with hot compresses. Two weeks later he noted that the testicle was gradually enlarging, and by October it was as large as a goose egg. Since that time it had become quite hard but had caused very little pain.

Examination revealed the right testicle to be hard, smooth, tense and somewhat cystic and of the size of a goose egg. The inguinal glands were "shotty" in character. The Wassermann test was negative. Laboratory examination gave normal findings.

*Treatment.*—Orchidectomy, followed by X-ray therapy.

*Pathological Diagnosis.*—Teratoma.

The patient returned April 29, 1926, with a small, movable mass below the umbilicus. The X-ray treatments were repeated. On February 8, 1927, masses were still present in the abdomen and the inguinal glands were enlarged. X-ray therapy was again employed. When he was last seen, on May 21, 1927, the masses were still present, but were not enlarging and the patient's general condition remained good.

CASE VII.—On January 16, 1926, a patient thirty-one years of age entered the Clinic, complaining of severe pain in the right groin, hip and testicle, which had been present for the preceding three weeks. The pain was constant and was increased by movement. The right testicle had been swollen and tender for an indefinite period. The patient had lost fifteen pounds during the preceding two months.

Examination showed the right testicle to be slightly enlarged, hard, tense and tender. The epididymis was tender to pressure and in the globus major and minor were uneven masses of the size of a pea. No nodules along the vas, and no abdominal masses could be palpated. The Wassermann test was negative.

*Treatment.*—Orchidectomy. X-ray therapy was advised.

*Pathological Diagnosis.*—Teratoma.

On July 15, 1926, a letter was received from the patient's attending physician stating that in the right upper quadrant of the abdomen there was a tumor larger than a grape fruit in size, quite hard and not tender. The patient had lost some weight.

CASE VIII.—On April 6, 1927, a patient fifty-three years of age entered the Clinic, complaining of an enlargement of the left testicle. An operation for hydrocele of the left testicle had been performed twenty years before, and the patient had had no further trouble until a year previous to this examination. At that time, following a strain, the testicle had begun to enlarge until it had attained the size of a grape fruit.

Examination revealed the left side of the scrotum to be greatly distended, tense and hard, with the exception of the lower part, which was fluctuant.

*Treatment.*—Orchidectomy. X-ray therapy advised.

*Pathological Diagnosis.*—Embryonal carcinoma.

CASE IX.—On April 14, 1927, a patient twenty-seven years of age entered the

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Clinic, complaining of an enlarged testicle. About two months before the right testicle had begun to enlarge, and it was becoming firmer, though it was free from pain or tenderness. The physician whom the patient had consulted had told him that the enlargement was probably due to an injury or to gonorrhœa and had treated the testicle with poultices.

Examination revealed the right testicle to be of the size of a goose egg. The scrotum was not tender to the touch but it was blue in color on account of the collateral circulation. The epididymis was normal. There was no evidence of metastasis. The Wassermann test was negative. The laboratory examinations gave normal findings.

*Treatment.*—Orchidectomy, followed by X-ray therapy.

*Pathological Diagnosis.*—Embryoma.

GROUP II.—*Two cases in which operation was advised but refused.*

CASE X.—On June 5, 1922, a patient thirty-four years of age entered the Clinic, complaining of a painless enlargement of the right testicle which had been increasing progressively since it was first noticed three months before.

Examination showed the right testicle to be enlarged to the size of an orange and very hard. The enlargement extended along the vas nearly to the symphysis. There was no evidence of metastasis.

Operation was advised but refused.

The patient died on April 24, 1923.

CASE XI.—On November 10, 1922, a patient thirty-two years of age entered the Clinic, complaining of pain in the back and hip. The testicle was enlarged, very firm and nodular. A diagnosis of tumor of the right testicle was made and operation was advised, but the patient refused treatment. He died five months later.

GROUP III.—*Three inoperable cases. In one case X-ray therapy was employed, in the other two it was advised.*

CASE XII.—On July 30, 1924, a patient thirty-nine years of age entered the Clinic, complaining of loss of appetite, fever, pain in the abdomen and constipation. These symptoms had been present intermittently for about three years, during which he had lost eighteen pounds.

Examination revealed a tumor of the left testicle, hard and firm in consistency and of the size of a tennis ball. It was not tender. In the left hypochondrium there was a hard, nodular mass which was slightly movable.

X-ray therapy was instituted and the patient's condition improved greatly. On September 9, 1925, an X-ray examination revealed evidence of a metastasis in the mediastinum. X-ray therapy was again employed and a röntgenogram made July 1, 1926, showed a normal chest.

On December 5, 1926, the patient noticed that his legs were weak and he soon suffered from numbness below the waist and from loss of sphincteric control. It was thought that this was probably a metastasis in the sixth dorsal segment of the spinal cord and X-ray therapy was again instituted. The patient was last seen on May 16, 1927.

CASE XIII.—On May 14, 1925, a patient forty years of age entered the Clinic, complaining of severe pain across the back. He had felt perfectly well until the sudden onset of the pain one month before. The pain was increased by movement and relief was obtained by lying down. Three weeks before, abdominal pain had developed in both lower quadrants, there was no nausea or vomiting, but the pain was increased after meals.

Examination gave essentially negative findings except for lordosis of the spine with marked limitation of movement in all directions. The testicles showed no evidence of pathological change. The Wassermann test was negative. An X-ray examination of the dorsal spine and of the intestines gave negative findings.

On July 2, 1925, the patient returned, still complaining of severe lumbar pain. A

large mass was present in the left supraclavicular region and the left testicle was considerably swollen, hard and firm. A large mass was also present in the lower abdomen.

After a course in X-ray therapy, an exploratory laparotomy was performed. Numerous large and small glands were found about the retroperitoneal space, and in the region of the eleventh and twelfth dorsal vertebrae, on the left side, there was a mass of the size of half an orange which was hard, somewhat irregular in contour, and apparently arose from the bone. One of the retroperitoneal glands was excised for diagnosis.

*Pathological Diagnosis.*—Teratoma.

The patient died on September 9, 1925.

CASE XIV.—On May 5, 1927, a patient thirty-nine years of age entered the Clinic, complaining of an enlargement of the left testicle which had first been noticed two years previously. Slight pain was present, which radiated down the legs. There had been no loss of weight. The testicle had been gradually increasing in size. About eight months before, the patient had noticed a mass in the abdomen, which had also increased in size.

Examination showed the left testicle to be enlarged, firm and smooth. Fluid was present in the scrotum. There was a large, fixed mass in the lower abdomen.

X-ray therapy was prescribed.

GROUP IV.—*Nine cases in which orchidectomy had been performed previous to our examination.*

In five cases X-ray treatment was administered, in two it was advised, in two cases no treatment was advised.

CASE XV.—On August 25, 1922, a patient thirty-five years of age entered the Clinic, complaining of oedema of the left leg. He stated that in 1918 the left testicle had become enlarged and tender and had been incised. It had drained for one year and then the testicle was removed. Later the cord became involved and was also removed, and a large gland in the left inguinal region was also removed later. The patient had lost fifteen pounds.

Examination showed broken-down glands in the left inguinal region, and enlarged glands in the right inguinal region. There was marked oedema of the left leg but there was no other evidence of metastasis.

*Clinical Diagnosis.*—Sarcoma.

*Treatment.*—X-ray therapy.

A letter addressed to the patient March 25, 1927, was returned, marked "deceased", but the date of his death is unknown.

CASE XVI.—On September 2, 1925, a patient thirty-eight years of age entered the Clinic, complaining of pain in the back and down the right leg. Four years before, the right testicle had become swollen and had been removed. He had remained well for three and a half years but a mass had then appeared in the right inguinal region. It was removed and a diagnosis of carcinoma had been made. Shortly after this operation the patient had begun to suffer from pain in the back, which was constant and so severe that morphin had to be administered. The patient had lost eighteen pounds during the month before we saw him.

Examination revealed an emaciated, pale individual who showed evidence of a marked loss in weight. The right and left inguinal glands were enlarged; there were enlarged glands in both supraclavicular regions; there was one large gland in the right groin, a large mass in the left side over the abdomen, and X-ray examination revealed extensive metastases in the chest. (Fig. 3.)

*Pathological Diagnosis.*—Carcinoma.

No treatment was advised.

The patient died on October 17, 1925.

CASE XVII.—On June 11, 1923, a patient thirty-two years of age entered the Clinic, complaining of a tumor in the groin and of a lump in the scrotum which had



## MALIGNANT TUMORS OF THE TESTICLE

recurred following an orchidectomy. When the patient was a boy, his left testicle had been slightly injured. In March, 1923, he had consulted a physician concerning an enlargement of the left testicle which he had first noticed about fifteen months before. A small, hard nodule had appeared on the lower part of the testicle and the testicle had begun to enlarge rapidly and to become painful. The patient had lost considerable weight and was becoming pale. Orchidectomy was performed and a diagnosis of sarcoma was returned by the pathologist.

In April, the patient had noticed that a small lump was developing at the upper angle of the incision and a sinus had formed, which was discharging bloody serum. X-ray therapy was employed.

Examination revealed a well-developed and well-nourished man. Along the left spermatic cord there was an irregular, hard, nodular growth, and in the groin a swelling was noted, the size of a hen's egg, the skin over which was ulcerating.

*Pathological Diagnosis.*—Spindle-cell sarcoma.

More X-ray and radium therapy was advised.

CASE XVIII.—On July 9, 1924, a patient twenty-four years of age appeared at the Clinic to ask advice concerning post-operative treatment following orchidectomy for a malignant growth of the testicle. He had first noticed the swelling of the testicle in the spring of 1923. There had been no pain, the size alone calling his attention to the swelling. At one point the swelling had been very firm but had later become soft. A diagnosis of tuberculosis had been made and the testicle was removed. The pathological examination proved that it was a malignant growth and X-ray therapy was instituted.

After the operation the patient had noticed a lump at the end of the cord which had never disappeared and about two months before he came to the Clinic, a lump had also appeared in the incision and had begun to enlarge. Both lumps had been removed on June 12, 1924.

Examination revealed enlarged glands in the right groin; a sinus in a recent scar in the scrotum was discharging bloody pus, and the right inguinal region was slightly painful and swollen, but showed no distinct masses.

*Clinical Diagnosis.*—Sarcoma.

X-ray therapy was advised.

CASE XIX.—On March 30, 1925, a patient thirty-eight years of age entered the Clinic, complaining of pain in the right side of the back and extending down the legs, and of a tumor in the abdomen. A little over a year before, the patient had noticed a swelling of the testicle, which had been painful and tender. Orchidectomy had been performed and a diagnosis of sarcoma was made by the pathologist. X-ray therapy had been instituted. About six months after operation the swelling in the abdomen had appeared and this was associated with pain in the back and down the legs. The upper portion of the right thigh was also swollen. X-ray therapy was again employed.

Examination revealed a tumor the size of a grape fruit under the umbilicus. The tumor was fixed, slightly tender, and showed no fluctuation. The right leg was badly swollen and œdematous. X-ray examination revealed no other evidence of metastasis.

*Pathological Diagnosis.*—Sarcoma.

X-ray therapy was given.

The patient died June 8, 1925.

CASE XX.—On December 11, 1924, a patient forty-nine years of age entered the hospital, complaining of pain in the right inguinal region and in the right shoulder and joint. One year before the right testis, which had never descended, had gradually enlarged and had become quite painful. A hernia had also appeared. The testicle had been removed and the hernia repaired in September, 1924. Since the operation the patient had noticed the pain and swelling in the right inguinal region.

Examination revealed a well-healed scar in the right inguinal region and a line of

hard, enlarged, tender glands, extending laterally from the symphysis from four to six centimetres. These glands seemed to be fused, but the overlying skin was free.

A biopsy was performed December 12, 1924.

*Pathological Diagnosis.*—Embryonal carcinoma.

The patient died March 6, 1925.

CASE XXI.—On March 5, 1925, a patient twenty-four years of age entered the Clinic, complaining of pain in the back and of tumors in the abdomen and in the left side of the neck. A right orchidectomy had been performed on October 29, 1924. The testicle had been enlarging painlessly for two years prior to this operation, and in the last four months before operation the patient had lost fifty pounds in weight. There had been a mass the size of a dime in the neck before operation and after the operation this had begun to enlarge. About three weeks after operation the patient had noticed that a mass was developing in the site of the incision and was enlarging quite rapidly. The pain in the back had begun in January and had become very severe; it was increased by movement.

Examination revealed an anæmic and cachectic patient who showed evidence of a marked loss in weight. There was a large nodule in the left supraclavicular region, of the size of an egg, and in the lower abdomen was a large mass, stony hard in consistency, fixed, and extending deep into the left lumbar region. (Fig. 5.) A mass was also present in the site of the incision.

*Clinical Diagnosis.*—Teratoma.

X-ray therapy was recommended.

A letter addressed to the patient on March 25, 1927, was returned marked "deceased".

CASE XXII.—On March 25, 1925, a patient twenty-one years of age came to the Clinic for post-operative treatment for tumor of the testicle. Two weeks before the right testicle had been removed and X-ray therapy employed. A pathological diagnosis of embryoma had been made.

Examination showed a few hard, shotty glands in the groin; otherwise there was no evidence of metastasis but an X-ray examination made on October 21, 1925, gave evidence of a destructive lesion in the upper anterior sternum, which was believed to be a metastasis. (Fig. 4.)

*Pathological Diagnosis.*—Embryoma.

*Treatment.*—X-ray therapy.

Four months later nodules developed in the skin over the body and the extremities. The patient died on February 18, 1926.

CASE XXIII.—On August 24, 1926, a patient thirty-three years of age entered the Clinic for X-ray therapy, following an orchidectomy for malignant tumor of the testicle. Operation had been performed in November, 1925, and 14 X-ray treatments had been given after operation.

Examination revealed no evidence of metastasis.

*Clinical Diagnosis.*—Teratoma.

*Treatment.*—X-ray therapy.

When last seen, on May 24, 1927, the patient's condition was good and there were no signs of metastasis.

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# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

*Stated Meeting Held October 26, 1927*

The President, DR. FRANK S. MATHEWS, in the Chair

### PERFORATING DUODENAL ULCER—SECOND PORTION—SIMULATING DIVERTICULUM OF DUODENUM

DR. ALFRED STILLMAN presented a man, twenty-eight years of age, who had been well up to a month before his admission to Roosevelt Hospital in October, 1926, when he began to have pain and soreness in the epigastrium and indigestion. The pain was nearly continuous and worse after eating, radiating to the back. Bicarbonate of soda somewhat relieved him. He had sour eructations and vomited food but never any blood. He had lost some weight. Doctor Steiner, the röntgenologist, reporting on the X-ray gastric series, said the stomach and cap were shown without filling defect or deformity, but that there was a well-defined pouch apparently connecting with the descending arm of the duodenum. The stomach emptied at six hours, but the pouch was retentive and had all the characteristics of a duodenal diverticulum. At operation a large perforation, the size of a 25-cent piece, with thickened edges adherent to the gall-bladder, was found in the second portion of the duodenum. The perforation was closed by two layers of catgut stitches in the transverse axis and a posterior gastro-enterostomy made. The patient made a nice recovery.

### TANNIC ACID TREATMENT OF BURNS

DR. FENWICK BEEKMAN presented four cases of burns of the body treated by tannic acid.

CASE I.—A boy, seven years of age, who was admitted to the wards of the Children's Surgical Service at Bellevue Hospital, July 1, 1926, suffering from second and third degree burns of the skin of the lower abdomen and groins, his clothing having caught fire from some burning gasoline.

It was estimated at the time that from 10–15 per cent. of his body surface was involved. The tannic acid treatment was immediately started. July 21 he was transfused with 400 c.c. of blood, and August 3, one day lacking five weeks, the burned surface was in such condition that it was grafted with one hundred full thickness pinch grafts from his thigh. Ninety-five per cent. of these grafts took. He was discharged from the hospital August 31, entirely healed. At no time during his treatment was his temperature over 102, and it came down to its normal level within a week after his admission.

In this case there was a child, severely burned, whose entire stay in the hospital until cured was less than two months, who never showed marked signs of toxæmia and who healed promptly when skin grafted. It may be noted, however, that he has a large keloid of the scar at this time, but no contraction resulting in interference in the function of his hip.

CASE II.—A girl, nine years of age, who was admitted to the Children's Surgical Service at Bellevue Hospital, January 16, 1927. Shortly

## TANNIC ACID TREATMENT OF BURNS

before admission to the hospital her dress caught on fire from a candle resulting in a second and third degree burn of the skin over the anterior portion of the chest, abdomen, upper thighs and left wrist. In addition there was slight burning of the face, the eye lashes and eyebrows being entirely singed off. It was estimated that from 12-18 per cent. of the body surface was involved by this burn.

The tannic acid treatment was started immediately after admission. February 22, 1927, about five weeks following admission, the burned areas on her abdomen and thighs were covered with healthy granulation tissue in which there were multiple islands of epithelium. This area was strapped with strips of adhesive plaster.

March 12 she developed erysipelas at the edges of the wound on the abdomen. May 19, she was entirely healed and discharged home cured, just four months after being admitted. Her temperature at no time was above 102, excepting during her attack of erysipelas. The period in which her temperature was up lasted only about two weeks.

There is now a soft pliable scar. In this case there was a fairly large proportion of the abdomen involved, only a moderately severe toxæmia and a wound surface which healed rapidly without any operative procedure.

CASE III.—A girl, three years of age, who was admitted to the Children's Surgical Service at Bellevue Hospital, June 28, 1927. Just before admission her clothing caught fire and she was severely burned on her left arm from the axilla to the wrist and on the left side of her chest. This was a second degree burn. She was discharged home August 13, about six weeks after admission, entirely healed. Her temperature shortly after admission rose as high as 100.8°, but promptly dropped to normal by the end of the first week and did not rise again except during an attack of tonsillitis.

On removal of the tanned portion of the skin it was found that the wounds had entirely healed except in a few small areas. This child had a second degree burn covering a large surface. She had practically no toxæmia and healed rapidly under the tanned portion of the eschar.

CASE IV.—A boy, five years of age, was admitted to the Children's Surgical Service at Bellevue Hospital, August 1, 1927, and discharged nine days later. Shortly before admission a pot of boiling water had fallen from the stove, scalding him on the left side of the face and neck. The mother applied some form of grease. On admission there were many blebs on the face, neck and shoulder. Immediately upon admission the grease was removed with benzene and a 5 per cent. solution of tannic acid as a wet dressing was applied. Only about 50 per cent. of the burned area, however, became tanned because of the grease which had been previously applied. The healing took place rapidly and the patient never showed any signs of toxæmia. At present it is to be noted that the scars have almost entirely disappeared.

DOCTOR BEEKMAN said that he had never found tannic acid ointment for the face to be efficient and on consultation with the Ophthalmological Department at Bellevue Hospital he was told that a solution of tannic acid would do no harm to the eyes unless there was a corneal ulcer present. He had constantly been using tannic acid on the face, however, taking the precaution of keeping the eyes greased with boric ointment.

During the years 1924, 1925 and 1926, there had been admitted to the Wards of the Children's Surgical Service at Bellevue Hospital one hundred and thirty-four cases of burns. The tannic acid treatment had been first used in the fall of 1925. Ruling out the deaths which occurred in the first forty-eight hours after admission, the mortality had dropped from 10 per cent. to

3 per cent. since they had commenced to use this treatment. The average hospital stay for each case in 1924 was thirty-three days; that in 1926 while the tannic acid treatment was being used it had risen to forty-four days. This increase in the average length of treatment being explained by the fact that severe burns which would otherwise have died remained in the hospital for a longer period of time.

#### THE TANNIC TREATMENT OF BURNS

— DR. ALBERT E. SELLENINGS read a paper with the above title.

DOCTOR MCCREERY said he thought that there was one point in the use of tannic acid which had not been emphasized in the cases that had been shown. Without doubt the tannic acid treatment was of very great value as a routine method of treating burns. Its value, however, depended to a very great extent on the time at which it was instituted and on the character of any first aid treatment that might have been used. Where any of the standard home remedies, such as carron oil or other forms of grease, had been used the tannic acid treatment was much less efficient even if strenuous measures were taken to remove the grease before the application of the acid. Furthermore, its use in late cases in which infection had developed was not only unsatisfactory but in his experience had done considerable harm by damming up the exudate under a firmly tanned wall. Leaving out these two classes of cases, however, he felt that the use of the tannic acid was a distinct advance and agreed in the estimates of its value in diminishing suffering and in shortening hospital and out-patient treatment.

DR. ROBERT T. MORRIS asked if it would not be possible to first control the infection and then apply the tannic acid. He had seen many cases two or three days after an extensive burn had been received and had treated them with immersion in various antiseptic baths. In two or three days the septic feature was disposed of and he then applied a covering of sterile animal membrane with scarlet red. Personally he had had no experience with tannic acid treatment and he wished to know if it could be administered after the infection had been brought under control, thereby adding what seemed to be a most important new treatment for burns.

DR. JOHN J. MOORHEAD considered tannic acid a method of chemical débridement. He considers that surgical débridement should be limited to third degree burns and others of a distinctly limited type under hospital control preferably where an immediate skin graft could be done.

There have been waves of enthusiasm for various kinds of treatment in burns as well as in other wounds, for essentially a burn is a wound due to heat. Now there is a wave of tannic acid popularity; not so long ago it was paraffin and Dakin's solution. All this indicates that there is no one best method in burn therapy. At certain stages the less done in the way of dressings and the more in the way of open air and electric exposure, the better for the patient.



## THE TANNIC TREATMENT OF BURNS

There are three important indications in the treatment of burns—preventing shock, relieving pain and avoiding contractures.

DR. KIRBY DWIGHT emphasized the secondary rise of temperature in these cases of burns treated with tannic acid. A typical case would be as follows: A patient with an extensive third degree burn has been admitted to the hospital and tannic acid used. One is astonished to see that the patient does not suffer extreme toxæmia, considering the extent of the burn. The temperature on the second day is not much higher than on the first. The skin is tanned, the patient is without pain and one feels that the treatment of the burn, as far as the patient's life is concerned, is finished, and all one has to do is to wait for the damaged tissue to come away. Unfortunately that is not always the case. In a number of patients, after this satisfactory state of affairs has lasted from ten days to two weeks, there is for no apparent reason a gradual rise of temperature, one-half a degree a day, until the patient is in a dangerous condition again. What causes this secondary rise of temperature has not been determined. It is not the infection of staphylococcus or streptococcus that one sees in other wounds; there is no pus and the eschar is firmly adherent to the underlying tissue. Doctor Dwight said that his theory was that the deeper layers of this tanned tissue, in contact with the body fluids, might gradually be breaking down and proteïn toxins be getting into the blood. Whether this is the case or it is an infection, it is important that this tanned skin be removed before the toxæmia has continued too long.

DR. FREDERIC BANCROFT agreed with Doctor McCreery in that infection does occur beneath the tannic acid membrane. He said that prior to 1926 he had lost several cases treated with tannic acid because he had not removed the membrane and treated the underlying cellulitis. The case would go on for two or three weeks running a temperature of 102 or 103, not appearing very sick, and then would suddenly die. The speaker has always been impressed with the belief that the infection is anaërobic. There is a tanned membrane on one side and a scar tissue base on the other—an ideal area for anaërobic growth. The blood chemistry with the sodium chloride retention closely resembles that seen in gas bacillus infection. These patients clinically do not act as if they were toxic from destruction of tissue or infected by either the staphylococcus or streptococcus. Their clinical course resembles a sub-acute attack of gas bacillus infection. He is sure that during the last year several cases have been cured by treating the cellulitis which has developed beneath the tannic acid membrane by its removal and the treatment of the granulating infected area with a 1/5000 solution of acriflavine dressing. It is important in children, where there is a tendency toward contractures, to treat the epithelializing surface first and not the contractures. After epithelialization has occurred, contractures can be more readily dealt with. Moreover, if doctor and nurse each day while making rounds extend the limbs generally a great deal can be done to prevent the formation of contractures. He had used débridement for the introduction of the tannic acid

treatment and believes that he saved some cases by it that would have died otherwise; but does not think it compares to the tannic acid treatment now in use.

DR. FENWICK BEEKMAN stated that what impressed him in the tannic acid treatment of burns was the shortening of the period of healing. The treatment of burns can be divided into three periods: The immediate, the intermediate and the late. The immediate period is the time until the eschar separates. During this period we treat the individual to save life by preventing toxæmia and infection. In this treatment the period is shortened and made less severe than in the past types. The intermediate period is that of healing and we pay the most attention to local condition. When the eschar separates, those cases uncontaminated before the tannic acid was applied, will have a clean granulating surface and can be grafted sooner than formerly when burns were treated by the older methods. In this period by promoting healing we are preventing contractures. The faster the wound heals the less the scar tissue. The late period is the one in which contractures are corrected. The first two periods are shortened and there are less severe contractures if the burn is treated properly from the first. It is necessary to get the cases early; all the home treatments, greases, etc., interfere with the use of tannic acid and should not be used as first aid methods. Another important thing to do to get complete tanning, is to remove all loose epidermis as aseptically as possible. The eschar must never be punctured as this will introduce infection under it; it acts as a confining dressing.

DOCTOR SELLENINGS, closing the discussion, said that he appreciated that there was nothing new in his paper, but he had felt that the contribution of Davidson was so outstanding that it should be emphasized. He did not consider tannic acid treatment a fad; it is a distinct advance because it takes into consideration more definite pathology, limits toxæmia to a local area and has a logical basis. The literature gives a mortality as high as 50 per cent. from severe burns and under tannic acid treatment severe burns have a mortality of 20 to 25 per cent. As regards the use of tannic acid in burns that are seen late, it has been found that after the surface has been sterilized the tannic acid has the same effect upon epithelial growth as when applied in fresh burns. In a few cases tannic acid ointment has been applied to granulating wounds other than those following burns and the effect has been very striking. There is no doubt but that tannic acid stimulates epithelial growth.

*Stated Meeting Held November 9, 1927*

The President, DR. FRANK S. MATHEWS, in the Chair

#### GRAVES' DISEASE IN THE MALE

DR. EDWARD W. PETERSON presented a man, aged forty-two years, who was admitted to the Post-Graduate Hospital, May 27, 1927, on account of marked loss in weight with increasing nervousness and loss of strength. He had always been of a quiet, placid disposition previous to present illness. During the past six or seven months he noticed that he had become increas-

## CONGENITAL GOITRE

ingly nervous, easily upset and excited, with palpitation of heart, tremor of hands and a quivering sensation in various parts of body and legs. When he leans over he becomes dizzy. There is dyspnoea on slight exertion. He has lost forty-two pounds in weight, with increased nervousness and muscular weakness. He appears thin and emaciated, weighing 108 pounds.

Physical examination showed a moderate exophthalmos, Von Graefe and Moebius' signs positive, thyroid very hard and only slightly enlarged. Bruit present. Heart regular, rapid, soft systolic murmur. Rate 100-130. Electrocardiographic study—negative, except for rate. Basal metabolism plus 48 (after entering hospital, plus 51).

Patient responded nicely to preliminary rest and iodine treatment, and after about one week operation was performed. A subcapsular bilateral resection of practically all of the thyroid was done June 3, 1927. Since operation there has been progressive improvement in the patient's condition. He has gained thirty-two pounds in weight. Tremor, nervousness and tachycardia have disappeared. He has been back at his work for several months.

The pathological report sustained the diagnosis of hyperplastic goitre in a stage of remission.

DOCTOR PETERSON then presented a man, fifty-three years of age, who was admitted to hospital, July 13, 1927, suffering from thyroid enlargement of six or seven months' duration, with nervousness, irritability and instability (eight months), voracious appetite and thirst, progressive loss of weight and strength (seven months) about twenty pounds, fine tremor of hands (nine months), exophthalmos, night sweats, palpitation of heart.

The man was thin and poorly developed, weighing 112 pounds, with wide staring exophthalmos, restless and nervous, perspiring profusely. The thyroid presented bilateral enlargement, bruit on auscultation; marked visible pulsation of neck. The heart's action was rapid, irregular as to rate, rhythm and intensity; blood-pressure 118/60; attacks of auricular fibrillation. Rate 120-160; fine tremor of hands; no oedema of feet and legs. The most important symptoms in this case were the rapid heart action, with attacks of auricular fibrillation, the extreme restlessness and the marked tissue dessication.

After about a week of rest in bed, with sedative treatment, the basal metabolism was plus 74. Lugol's solution was given in ten-drop doses, three times a day, and after nine days of its administration, on July 26, 1927, a bilateral subcapsular resection of the thyroid gland was performed. The patient stood the operation well and has made a most satisfactory recovery. He is back at work again, and in excellent condition so far as heart action and nervous system are concerned. There has been a gain of fifty-three pounds in weight.

The pathological report sustained the diagnosis of hyperplastic goitre of Basedow's disease.

## CONGENITAL GOITRE

DR. EDWARD W. PETERSON presented a young man, now twenty-one years of age, who was first seen in July, 1916, when he was ten years of age, he being then sent to the Post-Graduate Hospital for treatment of a nodular irregular growth of the right lobe of the thyroid gland, which had been present since birth.

The family history was of interest. The mother had some enlargement of the thyroid gland. Two brothers died shortly after birth and both showed a swelling of the neck. An older brother had a similar swelling and had been operated upon in 1911, at the Lenox Hill Hospital. Later a swelling of the other thyroid lobe developed. This older brother showed definite evidences of cretinism.

The boy had measles when five years of age, otherwise he had always been well. He had an internal strabismus of the right eye. *Tonsils*—small, buried. The left testicle was undescended. He, too, showed marked evidence of hypothyroidism; viz.: backwardness in physical and mental growth, short, obese stature.

July 6, 1916, a right subcapsular lobectomy was done. At this time there was no evidence of trouble in the left thyroid lobe.

Pathologic report is as follows: *Microscopic*.—Portions of the gland still retain the general structure of the thyroid, but in other more or less circumscribed areas there is a very marked cellular hyperplasia and a distinct departure from normal. The thyroid arrangement is completely lost. The cells are grouped in irregular papillary masses with a loose fibrous stroma intervening. The cells stain deeply and are distinctly larger than normal. In general the growth appears to be proliferating in a distinctly atypical fashion, yet no mitotic dividing forms can be recognized. It is impossible to say whether the growth is now malignant, but it certainly presents characters suggestive of such tendency and in all probability if not completely removed would recur locally.

Following operation the patient was put on thyroid feeding. Improvement, both mental and physical, was rapid. After about a year, however, the family moved to another address and the patient was lost sight of, until May, 1927, when he again presented himself. He had been well until three weeks previously, when he noticed an enlargement of the left thyroid lobe, which had grown rapidly. In view of the malignant tendency in this case, operation was advised and was performed May 27, 1927.

The mass removed was a conglomeration of rounded adenomata, with small amounts of thyroid tissue intervening. The adenomata contained large cysts, some containing colloid and others filled with blood-tinged watery fluid.

Sections show a somewhat variegated structure. There are rather broad bands of cedematous fibrous tissue in which there are scattered thyroid alveoli variable in size and shape and lined by an epithelium in which the nuclei stain in an irregular fashion. There are also large cystic alveoli and in some places well-defined actively growing adenomata in which the epithelial cells are quite tall with occasional mitotic division figures in them. In these regions there is little or no colloid. The variation in growth activity permits one to recognize more deeply stained spots in the section with the naked eye, these spots representing more actively growing small adenomas.

The picture is somewhat difficult to interpret and especially difficult for prognosis. Actively growing lesions of this sort have a tendency to recur locally and even to give rise to distant metastases. However, the present example shows definite encapsulation of all the actively growing spots. The possibility of recurrence should, however, be kept in mind.

Practically the whole of the thyroid gland has been removed in this case. Thyroid extract seems to be called for here.

DOCTOR PETERSON also presented a young woman, age twenty-three, who was admitted to the Post-Graduate Hospital, January 18, 1905, when five weeks old, on account of a relatively large tumor on the right side of the neck.

There was some difficulty in breathing for the first two hours after birth, after which there was neither dyspnoea nor dysphagia. Aside from the deformity, the tumor apparently produced no symptoms. The growth was on the right side of the neck, behind and to the inner side of the sternomastoid muscle, extending from the level of the jaw downward nearly to the clavicle.

## CHOLELITHIASIS AND LARGE UMBILICAL HERNIA

The tumor was made up of two masses, the larger situated above. It was smooth on the surface, of firm consistency, and did not fluctuate at any point. Below and to the side there was distinct palpable nodulation.

An incision was made parallel to the border of the right sternocleidomastoid muscle. A fibrous capsule which surrounded the growth was opened and the tumor was dissected out without difficulty. There was very little hemorrhage. Several times during the operation artificial respiration had to be resorted to. The wound was closed without drainage. For twenty-four hours after the operation the infant had to be prodded occasionally, as the breathing would stop. A nurse was in constant attendance and would do artificial respiration at such times.

The temperature rose to 105° F. shortly after the operation and then gradually declined. There were no special features until the ninth day, when there occurred a convulsion lasting for five minutes.

On the thirteenth day there was twitching of the extremities, and the eyes rolled from side to side. On the fourteenth day there were almost constant convulsive movements of the hands, arms, and legs, with twitching of the facial muscles and rolling of the eyes. It was about this time that the pathologist reported the specimen to be a "congenital thyroid tumor" (goitre). Believing from the appearance of the two lobes making up the growth, that the whole thyroid gland had been removed, thyroid extract was started at once, followed by a cessation of the tetany. At that time palpation of the neck revealed no evidence of any remaining thyroid tissue.

The thyroid feeding was kept up for the first four years of the patient's life, and was then discontinued.

At regular intervals since thyroid extract and iodine have been given, there have never been any evidences of cretinism. The development both mental and physical up to the age of puberty was perfectly normal. At this time a slight enlargement was noted on the left side of the neck, corresponding to the left lobe of the thyroid. There is now a small adenomatous enlargement of the left lobe which will require careful watching.

The original tumor removed was horseshoe in shape; one side composed of a large elongated tumor mass measuring 6 cm. in length, 4 cm. in width, 3 cm. in thickness. The other side is composed of a small tumor measuring 4 cm. in length, 2½ cm. in width, and 2 cm. at its greatest thickness. These two tumors are joined at the concavity of the horseshoe by an isthmus of fibrous tissue. Both of the tumor masses have a slightly irregular lobulated appearance.

Microscopic sections taken from both tumors showed the same structure which is that of the thyroid gland. The acini have undergone a slight adenomatous proliferation and are filled with a very dense colloid material, the greater number of them being very much distended by it to the dimensions of small cysts. The epithelium is very much flattened by intra-acinus pressure of the colloid. Nowhere does the epithelium show any malignant proliferation. The entire growth is surrounded by a thin, fibrous capsule.

## CHOLELITHIASIS AND LARGE UMBILICAL HERNIA

DR. EDWARD W. PETERSON presented a woman, fifty-nine years of age, who admitted to treatment on account of an umbilical hernia, which was first noticed twenty-five years ago, and which has gradually grown until it has become extremely large. It is incarcerated and irreducible. She also complained of attacks of abdominal pain accompanied by nausea and vomiting, at times for the past ten years. The attacks of abdominal pain had become

much more frequent during the past two or three years. About three years ago there was jaundice, accompanying an attack, and it lasted for three weeks. The pain was in the right upper abdomen and radiated to the back, was accompanied by nausea and vomiting, and, of late, by chills, fever, and sweats and a loss of nearly fifty pounds in weight. She was emaciated and greatly weakened by her pain, sepsis and inability to take nourishment.

On May 26, 1927, under spinal anaesthesia, a long transverse elliptical incision was made, exposing the contents of the umbilical hernia. Incarcerated omentum and large, and small intestine with many adhesions, were found in the hernial sac. A large piece of omentum was resected and the intestinal adhesions were freed. It was possible through the hernia incision to expose the gall-bladder. It was quite small, its walls much thickened, and it contained several stones. A large stone was also found in the common duct.

A cholecystectomy and a choledochectomy, with removal of the common duct stone, were done. A stab wound was made through which a tube drain into the common duct and a cigarette drain to the gall-bladder bed were introduced. A Mayo closure of the umbilical hernia was done.

The patient made a slow but satisfactory convalescence and is now in excellent general condition.

DR. CHARLES L. GIBSON presented patients as follows:

#### GASTRO-ENTEROSTOMY FOLLOWING ADHESIONS AFTER CHOLECYSTECTOMY

A woman of forty-eight, who has had two previous operations by another surgeon, a cholecystoduodenostomy in 1924, and a cholecystectomy in 1925. She was admitted for the third time in February, 1927, on account of epigastric pain and vomiting—vomit contained blood. At this time a duodenal ulcer was found; an Ewald meal showed high acid content. Discharged to country as she refused operation. While in country she had severe epigastric pain and vomited blood on several occasions. Lost weight.

Admitted April 19, 1927, for operation. Examination showed a pale, undernourished, middle-aged woman with flabby abdomen and tenderness in mid-epigastrium. At operation diffuse adhesions were found over the entire right abdomen and the antrum and duodenum were quite compressed by these adhesions. No ulcer found. It was felt unwise to attempt to disturb the dense mass of adhesions which occupied the site of the previous operation, on account of the danger and difficulty of so doing and because it has been the operator's experience that a gastro-enterostomy gives complete relief in such conditions. This, therefore, was done. The patient made an excellent recovery. She was discharged home on the eleventh post-operative day with wound healed. Fluoroscopy six weeks later showed the stoma patent and functioning normally. Follow-up examination six months after operation showed an excellent result. Patient absolutely free from all symptoms.

#### CHOLECYSTENTEROSTOMY FOR CHRONIC PANCREATITIS

A young mother, age twenty-one years, was admitted to St. Luke's Hospital, July 24, 1902. History.—Seven months ago her child was born. One month later she had a sharp attack of pain in the right hypochondrium, shooting into the back. Such attacks have recurred about every week since, increasing in severity and followed in some instances by jaundice. She has lost weight and strength.

## PERINEPHRITIC ABSCESS

On examination, a fairly well-nourished young woman. The skin and mucous membrane are of light yellowish hue. Abdomen.—Free border of liver thought to be one-half inch below free border of ribs. Provisional diagnosis. Cholelithiasis.

Operation, July 25, 1902. Incision parallel to free border of ribs. Gall-bladder not enlarged and contained no stones. No dilatation of nor stones felt in ducts. The pancreas was found to be somewhat hard and nodular and running across it were a number of dilated blood-vessels. Right kidney much more movable than normal. An anastomosis between the gall-bladder and upper jejunum was made with a Murphy button. Diagnosis: Interstitial pancreatitis.

DOCTOR GIBSON observed that he preferred using the upper jejunum rather than the stomach or duodenum for anastomosis of the gall-bladder. He believes that the objections to the use of the upper intestines are quite theoretical, as several late observations, including this one, fail to show any deleterious effects.

The post-operative course was uneventful. The patient passed the button on the seventh day. Discharged August 14, 1902.

In June, 1927, patient reports for another condition and states that she has never had any manifestations which might be referable to her pancreatitis. She has enjoyed excellent health, has borne several children, and has never had a suspicion of any gastro-intestinal disturbance. At the present time it is over twenty-five years since operation.

## POLYA-MAYO EXCLUSION FOR DUODENAL ULCER

The patient was a man of thirty-one years, who was admitted complaining of pain in epigastrium of three months' duration. Physical examination showed a man in good physical condition, somewhat underweight, with some tenderness in the mid-epigastrium.

Fluoroscopic examination showed a post-pyloric ulcer of large size. At operation there was a large long ulcer just below the pylorus, extending down into the duodenum and did not seem resectable. Polya-Mayo exclusion was done.

Patient had a little heartburn following operation which gradually disappeared. Had no other symptoms at all and on discharge on the twelfth post-operative day had no symptoms.

Follow-up note October 20, 1927 (four months post-operative). Excellent condition and has gained in weight. Occasionally has some rather vague discomfort in the region of the wound.

This case is shown as a possible solution of the treatment of the severer form of duodenal ulcer which do not lend themselves to resection and where it is desirable to obtain greater guarantee of healing than may possibly be obtained by the usual gastro-enterostomy.

## PERINEPHRITIC ABSCESS

A man of twenty-seven years was admitted complaining of pain in the left lumbar region, radiating to the testicle, which he had had about two weeks before admission. Had no chills and fever since the onset and there was no urinary disturbances. No history of infective focus obtained. Examination showed tenderness and sense of mass in left flank. The urine was negative and leucocytes were 13,800 with 87 per cent. polymorphonuclears. This rose later to 28,000. The temperature ranged from 100 to 103.8. Under diagnosis of perinephritic abscess the usual kidney incision was

made and several ounces of pus evacuated from which was cultured the staphylococcus aureus.

The post-operative course was satisfactory. The wound rapidly cleared up under wet dressings and the patient was discharged on the thirteenth post-operative day with the wound nearly healed and in good general condition.

Follow-up note January 27, 1927. Excellent condition. No complaints.

About four days after operation a fair sized boil developed on the cheek which was incised. This is an interesting observation as in this case the suppurative focus was dormant.

DOCTOR GIBSON added that this patient was one of a series of twenty-five cases of perinephritic abscess which develops usually after some form of infection and gives practically always a culture of staphylococcus aureus. In the majority of cases a direct lesion of the kidney is not demonstrable, and urinary findings and manifestations are seldom present. The small number of women is in accordance with their usual immunity to boils and carbuncles.

In the literature some of these cases of perinephritic abscesses have been accompanied by a lesion described as a carbuncle of the kidney as first noted by Israel in 1901.

An interesting feature is the benign course of these cases, the constitutional manifestations subsiding at once with the establishment of drainage, healing is prompt and the subsequent recovery is that of perfect restoration to health.

Of these twenty-five cases, in addition to the perinephritic abscess, three of these cases also had a solitary abscess of the kidney. (a) Abscess in perinephritic fat which led down to an abscess in the lower pole of the kidney. (b) Abscess in posterior portion of the upper pole, and abscess formation in the retroperitoneal space. (This case also had a splenectomy for splenomegalia.) (c) Large perirenal abscess, also large opening on posterior surface of the kidney.

Twenty-three were males, two were females (92 per cent. males).

*Ages.*—One to ten, one case; ten to twenty, four cases; twenty to thirty, seven cases; thirty to forty, ten cases; forty to fifty, two cases; fifty to sixty, none; sixty to seventy, one case. (Sixty-eight per cent. between twenty and forty, 20 per cent. below twenty—12 per cent. over forty.)

*Duration of Symptoms.*—One to two weeks, fifteen cases; three to four weeks, seven cases; three months, one case; four years, one case; twenty years, one case.

*Previous History of Infection.*—1. Rheumatism lower extremities (six months previous). 2. Abscess of foot (three months previously). 3. Came in with carbuncle of neck (gives history of tendency to boils). 4. Frequent abscesses on many parts of body (subsequent readmission for osteomyelitis of femur and pelvis). 5. Two large boils on arm (three weeks previous). 6. Infected finger (two months previous). 7. Furuncle of neck (three weeks previous). 8. Developed perinephritic abscess in fifth week of typhoid fever. 9. Two boils on knee and one in submaxillary region (two months previous).



## RESECTION OF SUPERIOR MAXILLA FOR OSTEOSARCOMA

(*Note*.—One case developed acute arthritis on her eleventh post-operative day. One case developed boil of face on his fourth post-operative day. Transferred from Medical Side.—Thirteen cases (52 per cent.).

*Highest Temperature Before Operation*.—Ninety-eight, one case; 100 to 101, one; 101 to 102, one; 102 to 103, seven; 103 to 104, ten; 104 to 105, four; 105 to 106 one. Sixty-eight per cent. between 102 to 104, 20 per cent. over 104; 12 per cent. below 102.

*Culture of Wound*.—Staphylococcus aureus, 20; staphylococcus aureus and albus, 1; bacillus proteus, 2; typhoid bacillus, one; no report of culture, one.

*Culture from Blood*.—No blood culture, thirteen; blood culture sterile, eleven; blood culture positive, one; staphylococcus albus.

*Stay in Hospital—post-operative*.—Less than fourteen days, seven cases; fourteen to twenty-one days, eight cases; twenty-one to twenty-eight days, three cases; twenty-eight to thirty-five days, one case; thirty-five to forty-two days, two cases; fifty-three days (complicated by pleurisy with effusion); seventy-four days (complicated by typhoid fever); ninety days (multiple perinephritic abscesses—long convalescence); one case still in hospital.

*Results*.—Twenty-one excellent results; one case recovered from abscess; but patient when last heard from was very ill with his osteomyelitis. Two no trace of patient after discharge. One case still in hospital, nine days post-operative. Condition excellent.

## RESECTION OF SUPERIOR MAXILLA FOR OSTEOSARCOMA WITH PRESERVATION OF HARD PALATE. WELL NINE YEARS AFTER OPERATION

DR. JOHN DOUGLAS presented a girl, twenty-three years of age, on whom he operated in 1918. She had noticed a growth in the right nostril, four months previously, which had greatly increased in size until the time of admission to the hospital. It was then about five by three centimetres in diameter and completely filled the right side of the nose, deflecting the septum to the left and completely filling the nasal cavity, protruding from the right nostril and projecting into the nasopharynx posteriorly. The Wassermann was negative.

August 13, the growth was separated from the nasal cavity, drawn out in pieces and the nasal cavity well cleaned; when it was found that the growth had taken origin in and projected from the antrum. A frozen section was made from this tumor which proved to be an osteosarcoma. No giant cells were present. Two days later a resection of the superior maxilla was performed in the typical manner, with the exception that, instead of making the usual median incision through the hard palate in the median line, the mucous membrane and periosteum separated from the hard palate. An incision was then made through the bone in the median line and the superior maxilla removed in the ordinary way, the flap of periosteum and hard palate being then sutured to the divided edge of the mucous membrane of the cheek with the exception that at the posterior angle, where the hard and soft palate joined, an opening was left for drainage. Through this opening packing was inserted into the space left by the resection of the superior maxilla, thus leaving most of the roof of the mouth in place instead of

having the oral cavity continuous with that of the nasal as is usual after a resection of the superior maxilla. This was deemed safe in this case as the growth, while taking its origin from the antrum did not seem to involve the bone. Before doing the resection an incision was made in the neck and the glands excised and the external carotid artery ligated.

A further microscopical examination of the section removed showed tumor tissue of the same type as previously described, involving the antrum but not involving the bone, although distinct fragments of well-formed bone containing growing bone cells surrounded by a layer of osteoblasts was scattered through the tumor tissue. As before no giant cells were found.

The drainage opening has contracted and become smaller and patient now wears a plate with comfort, and the result is obviously better than if the large portion of the roof of the mouth had been removed, and while this may not be a safe procedure in a number of cases, as when the bone is involved in carcinoma, in this case the results justify the means employed.

#### OSTEOFIBROMA OF SUPERIOR MAXILLA

DOCTOR JOHN A. McCREERY presented a colored girl of eighteen years who was admitted to the First Surgical Division of Bellevue Hospital, in September,

FIG. 1.—Osteofibroma of superior maxilla. Removal with long standing freedom from recurrence. (McCreery.)

1927, complaining of swelling of left side of upper jaw. In 1919, a small tumor was removed from the upper jaw, apparently from within the mouth. It has been impossible to determine the nature of this growth. The tumor recurred and has grown slowly, the patient finally applying for relief because of the deformity and difficulty in swallowing.

On admission she presented a tremendous enlargement of the left side of the face (Fig. 1), apparently due to a tumor of the superior maxilla, which had gradually grown forward and downward so that the patient's face presented the appearance of a pig's snout. The mass was firm with areas of superficial ulceration. X-ray showed an apparently localized tumor measuring 12 cm. in diameter, involving the body of the superior maxilla, considered by röntgenologist to be an osteoma. A section of the growth was removed and was reported as a non-malignant mixofibroma.

With this diagnosis an attempt was made by Doctor Potter and Doctor Kaplan to remove the tumor with the endotherm knife. It was found, when cutting into the mass that the tumor was much more dense than had been

## FIBROMA OF LOWER JAW

expected and contained large amounts of bony tissue. As much as possible of this was removed with a chisel, the endotherm being of great value in controlling bleeding, which was rather free.

DOCTOR McWHORTER reported that the tissue removed weighed 300 grams and appeared to be made up of dense connective tissue and bone. After decalcification section showed dense masses of interwoven connective tissue, scattered through which were masses of adult bone. The tumor was moderately vascular and was considered to be an osteofibroma.

Four weeks after the partial removal of the growth, the sloughing surface had in large part cleared up and mucous membrane was growing across the raw area. At this time Doctor Kaplan implanted 30 radium needles, with some difficulty because of the dense fibrous and bony character of the lesion. The implantation of these needles has been followed by a considerable amount of necrosis and sloughing in the remaining portion of the growth, but has also been followed by the development of a small abscess below the left eye which has had to be incised and which evidently communicates with the tumor mass.

DOCTOR McCREERY said he was somewhat skeptical of the value of radium in the treatment of a tumor composed as this one was of dense connective tissue and bone. However since the implantation of radium emanation there had been a certain amount of necrosis, and it may be that in this case a further attempt at local removal will be a wiser procedure than the resection of the superior maxilla.



FIG. 2.—Fibroma of lower jaw.

## FIBROMA OF LOWER JAW

DR. JOHN A. McCREERY presented a man, thirty-five years of age, who was admitted to the First Surgical Division of Bellevue Hospital in May, 1927, complaining of a tumor in the floor of the mouth.

Four years before admission he noticed a small mass just behind the left lower incisor. This caused him no discomfort. The mass grew very slowly for about three and a half years at which time it was about 1 cm. in diameter.

At this time it commenced to grow very rapidly to its present size, annoying him because he could not close his mouth over the mass and he felt that it was a disfigurement. It did not interfere with his speech or the swallowing of soft food.

On admission patient presented a tumor which appeared to fill the floor of the mouth. It was firm, slightly lobulated, ulcerated over a small area anteriorly where it projected when an attempt was made to close the lips over it. It apparently arose from a small pedicle attached to the alveolar process of the lower jaw behind the site of the right lower incisors. The tongue could be protruded over the left upper border of the mass. X-rays were reported as showing destructive changes in the anterior portion of the alveolar process.

At operation a firm tumor, measuring 7 by 6 by 4 cm. was removed by division of the pedicle which was attached along the gum line behind the lower incisors, but which apparently did not involve the bone. Microscopically, the tumor consisted of swollen collagen fibres closely resembling keloid, and was called by Doctor McWhorter a fibroma. The operative incision healed without infection and up to the present time there has been no evidence of recurrence. Patient shown because of the rather unusual size of the tumor.

#### TUMORS OF THE UPPER JAW

DR. GEORGE H. SEMKEN read a paper with the above title.

# TRANSACTIONS

## OF THE

# PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held November 7, 1927*

The President, DR. CHARLES F. MITCHELL, in the Chair

### RUPTURE OF OVARIAN CYST

DR. DAMON PFEIFFER reported the case of a young girl aged eighteen, who had been seized with an attack of acute abdominal pain associated with vomiting, elevation of temperature and leucocytosis. A diagnosis of acute appendicitis was made by the attending physician and the physical examination on admission to the hospital tended to confirm this. At operation the condition proved to be intra-abdominal hemorrhage due to rupture of a small ovarian cyst. The speaker had called attention to this condition in some detail in a case reported to the Academy in 1926 and at this time wished merely to reiterate that this condition must be borne in mind as a cause of acute abdominal symptoms.

### TRAUMATIC RUPTURE OF THE URINARY BLADDER IN CHILDREN

DR. LLOYD B. GREENE, by invitation, reported two cases of traumatic rupture of the urinary bladder in young children. The first case was that of a boy, aged eleven, who was admitted to the accident ward of the Methodist Hospital, September 21, 1927, having been injured by an automobile. The patient was a deaf mute. There was an irregular deformity of the lower third of the left thigh and an irregular laceration of the lateral surface below this deformity. There was considerable bleeding from this wound. There was also a fracture of the descending ramus of the left os pubis. The abdomen was rigid and tender. A catheter was passed easily and pure blood obtained. Fluid introduced through the catheter was only partially recovered. A diagnosis of rupture of the bladder was made and operation was performed in the course of a few hours. The parietal peritoneum and the viscera were intact. There was considerable free blood and clots in the pelvis. The bladder was well mobilized in its lower half, and revealed a ragged punctured wound in the left lateral wall of the bladder near the sphincter and a clean tear about one inch in length in the anterior wall about the midline running to but not involving the sphincter. There was considerable bleeding from the lacerated pelvic fascia. The bladder was opened for thorough inspection and the laceration was closed from without. A number ten French catheter was fixed in the urethra and a DePezzer catheter fixed in the bladder and brought out through the suprapubic wound. The pelvis was packed with gauze and the wound closed. Urine was passed through the catheter seven hours after operation. The urethral catheter was removed on the fifth day. The packing was removed on the sixth day and there was no further bleeding. The DePezzer catheter was removed on the twelfth day, at which time normal urination had been fully established. The fracture was treated by overhead suspension in a Bryant frame. The child is still in the hospital.

The second case was that of a girl, aged four, who was admitted to the accident ward of the Methodist Hospital, August 5, 1927, after having been

struck by an automobile while playing in the street. There were bruises in the region of the both hips and slight bleeding from the vagina. The child was pale and listless, temperature 100.6, pulse 144, respiration 40. There was some rigidity over the entire abdomen, more pronounced on the left side. Pressure over the entire lower quadrant seemed to cause considerable pain. The signs of free fluid or gas in the peritoneal cavity were absent. She was given a hypodermic of morphine and soon thereafter slept. The X-ray examination showed a fracture of the right ischium without displacement. A number ten French catheter was introduced into the bladder and a few c.c. of blood were obtained by suction. A small quantity of water was introduced through the catheter but could not be recovered. The catheter was left in the urethra for half an hour. A few c.c. of blood were collected during this period. A tentative diagnosis of extraperitoneal rupture of the bladder was made and operation was elected. Through a left rectus incision the peritoneal cavity could be inspected without opening it. There was no evidence of intraperitoneal injury. The pre-peritoneal tissues in the region of the pelvis were suffused with blood. There were many clots and quite active bleeding, apparently from the depths of the pelvis. The bladder presented in the midline, above the pelvic brim. The urethra was torn across completely just distal to the bladder, the internal sphincter being intact, apparently. There was complete mobilization of the bladder except for the upper posterior segment. There were about 60 c.c. of clear urine in the bladder. The anterior and lateral walls of the vagina were severely lacerated and torn away from their anterior attachments back to the cervix. A small strip of the posterior vaginal wall, in which there were several longitudinal tears, was left in place. The cervix was readily seen by very gently retracting the bladder upward. The rectum was intact. The pelvic fascia was severely lacerated and bleeding profusely and the patient's condition was critical. A suprapubic cystotomy was done. A catheter was introduced through the external urethral orifice into the bladder and fixed with catgut. The bladder was drawn down into its normal position, using the urethral catheter as a tractor. The pelvis was packed with gauze and the wound closed. The patient reacted satisfactorily. The urinary output was small during the first fourteen hours. The pulse gradually came down and she secreted 840 c.c. of urine during the next twenty-four hours. The packing was removed on the tenth day. There was considerable bleeding and the wound was packed again. The urethral catheter which had been expelled from the bladder was lying free in the vagina and was removed. A strip of rubber tissue was placed in the vagina for drainage. There was a considerable secondary hemorrhage during the night. On August 20, blood count showed the hæmoglobin was 67 per cent., erythrocytes 2,250,000. She had a chill at this time followed by a temperature of 103° F. The urinary output fell to 400 c.c. The temperature assumed a septic type but returned to normal, after about one week. The suprapubic tube was draining very little, but the perineal dressings were constantly wet. Blood chemistry was within normal limits. The suprapubic tube was removed on September 9, and the wound allowed to close. On October 17, a small cystoscope was passed into the vagina and a ureteral catheter then introduced into the bladder. Sixty c.c. of five per cent. sodium iodide solution were instilled into the bladder and a cystogram made. This showed a normal bladder outline with slight displacement of the bladder to the left. The child was discharged on October 17. She now controls her urine and we hope at some future time to attempt reconstruction of the urethra by plastic operation.

## SUTURE OF THE TENDONS AND NERVES IN BOTH WRISTS

### SUTURE OF THE TENDONS AND NERVES IN BOTH WRISTS

DR. DANA WEEDE, by invitation, presented a patient aged twelve, who was admitted to the Germantown Hospital, November 2, 1926. This patient was shown for two reasons, first, the short time in which practically complete function had been obtained after the suturing of tendons and nerves, and secondly, to stimulate an interest in the study of the facts and details of anatomy. There is a tendency that has been growing in recent years to depreciate the value of knowledge of the details of anatomy and to curtail the time allotted to its study. This patient presented a problem, to be sure a little unusual in the extent of injury to structures, that would have disillusioned the mind of any surgeon of the wisdom in neglecting the careful study of anatomy. In being pursued by a playmate on November 2, 1926, this boy attempted to push open a swinging door, using both hands. His hands slipped from the lower half of the door, which was of wood, and broke through two panes of glass in the upper half of the door. He sustained two very jagged and extensive wounds of the flexor surfaces of both forearms. On the right side the four tendons of the flexor sublimis digitorum, the four tendons of the flexor profundus digitorum, the tendon and muscle fibres of the flexor carpi radialis and flexor longus pollicis, the median nerve, one-third the ulnar nerve, the radial and ulnar arteries and part of the annular ligament were cut. In the left forearm the tendons of the flexor carpi ulnaris, the flexor sublimis digitorum tendon to the little and ring fingers, the ulnar artery and part of the annular ligament, were cut. Within an hour after the injury the repair of the injured structures was begun. Badly torn muscle fibres and pieces of fascia that would have sloughed were excised, the ends of the cut tendons and nerves were freshened before suturing them. The tendons were sutured with No. 1 chromic catgut as were the torn muscles, and the nerves were sutured with fine silk. A very careful preparation of the hands and forearms with tincture of green soap, water, alcohol, ether and iodine was made before repair. A review of anatomy of the forearm and hands will aid in a better understanding of this case and show what to expect if normal function is to be reestablished. There are three flexors of the wrist, one of the radial side, the flexor carpi radialis, one for the ulnar side, the flexor carpi ulnaris, and one for the middle, the palmaris longus which is sometimes absent as in this case. The flexor carpi radialis also aids the extensor carpi radialis longior in abducting the wrist and the extensor carpi ulnaris aids the flexor carpi ulnaris in adducting the wrist. There is one flexor for the second phalanges of the four fingers, the flexor sublimis digitorum and one flexor for the third phalanges of the four fingers, the flexor profundus digitorum. The flexor longus pollicis flexes the second phalanx of the thumb. These muscles receive their innervation in the upper third of the forearm. The restoration of function therefore is only dependent in these structures upon proper suturing and union of the severed tendons. The foregoing accounts for the muscles that flex, abduct and adduct the wrist and the flexors of the second and third phalanges of the four fingers and the flexor of the distal phalanx of the thumb. The muscles that produce the other actions of the fingers are found in the hand and are innervated by one or two nerves, the median or ulnar. The muscles that aid in the flexion of the first or proximal phalanges of the four fingers are the four lumbricales and the anterior and posterior interosseous muscles. Beside their flexing action, they all by virtue of their insertion into the extensor tendons of the four fingers aid in the extension of the second and third phalanges. The lumbricales because of their insertion on the radial side of the fingers aid in drawing them laterally toward the thumb. The anterior interossei also draw

the fingers toward the middle finger, including the thumb, and the posterior interossei separate the fingers (moving the middle finger to either side) except the thumb and little finger this action being brought about in the case of the little finger by the abductor minimi digiti and of the thumb by the abductor pollicis. The little finger is further supplied with a short flexor inserted in the base of the first phalanx, the flexor brevis minimi digiti and an opponens minimi digiti which flexes and adducts the metacarpal of the fifth finger. The thumb is further supplied with a short flexor, the flexor brevis pollicis and an opponens pollicis which flexes and opposes the metacarpal of the thumb toward the ulnar side and an adductor pollicis which adducts the thumb. Considering now the nerve supply of the muscles of the hand, all are supplied by the ulnar except the abductor pollicis, flexor brevis pollicis, opponens pollicis and the two lumbricales on the thumb side which are supplied by the median. It is seen then that the ulnar supplies the greater number of muscles. Paralysis of the ulnar would result then in loss of flexion of the first phalanges of the four fingers, incomplete extension of the second and third phalanges of those fingers, inability to close and separate the fingers and partial inability to oppose the little finger on the thumb. The characteristic appearance of the hand in ulnar palsy is claw hand. Paralysis of the median nerve would result in loss of flexion of the first phalanx of the thumb, inability to abduct the thumb and partial inability in opposing the thumb to the little finger and a slight loss of power in drawing the index and middle fingers toward the thumb. As to sensation, both the ulnar and median nerves being mixed nerves, the median supplies the greater area of skin—the skin over the palm of the hand to the junction of the outer and middle thirds, the skin of the palmar surface of the thumb, index, middle and half of the ring fingers and the dorsum of those fingers over the distal phalanges. The ulnar supplies the rest of the skin on the palmar surface of the hand and the little finger and half of the ring finger.

Returning now to the patient, it was noted that he had perfect flexion, adduction and abduction of the wrists; strong flexion of all the phalanges of the four fingers and thumb on both sides; perfect opposition of thumb and little finger of both hands and separates well the fingers of both hands and closes them, except for a partial inability to close the little finger against the ring finger of the left hand. This is the only muscular disability. There has been a partial restoration of sensation over the palmar surfaces of both hands and all the fingers. The sense of touch is not as acute as normal yet; but with education and application the acuteness should return. It was interesting to note that motor fibres had regenerated more quickly apparently than the sensory. As to the post-operative treatment and course; the hands and forearms were kept in straight splints with roller bandages under the palms of the hands, for three weeks. They were not disturbed for two weeks. Every other day during the third week the fingers and wrists were moved and the splints reapplied. In a month passive motion and massage were begun twice a day and electrical stimulation with galvanism and faradism was given twice a week for five months. At the end of two months he was given a moderately hard tennis ball to carry with him to squeeze. The passive movements and massage were continued until four months ago. During the past four months he has had no special treatment except encouragement to continue doing wood carving and finger exercises on the piano. In December, one month after the injury, there was a spotty return of sensation in small areas. This gradually increased until there was sensation throughout in May. The muscles supplied by the median nerve on the right hand were the first to show regeneration which occurred about the end of December. Fairly complete muscle control was reestablished about the



## SUTURE OF THE TENDONS AND NERVES IN BOTH WRISTS

middle of February, excepting the lateral approximation of the little and ring fingers of the left hand and a weakness in extension of the second and third phalanges of these fingers. Complete muscle control, excepting for this residual weakness in approximating the little finger against the ring finger was established by the end of the tenth month. The wounds remained absolutely free from infection until they had completely healed, which made possible to a large degree the excellent result.

DR. JOHN H. JOPSON said that two months ago he was summoned to the Bryn Mawr Hospital at 2.30 in the morning to see a man who had cut the tendons of the back of his hand. He had put his hand through the windshield of an automobile, cutting both tendons along the short extensor of the thumb between the metacarpal and the phalanx. The preparation and suture of the tendons took about an hour and a half. The speaker believes that such time is time well expended. He has now in his care a patient with a number of lacerations of the hand, who was first treated in another hospital and who now presents a condition opposite to that shown to-night; his hand was saved with difficulty and will be probably functionally useless as long as he lives. In this last case Doctor Jopson used black silk; for some time, he has been dissatisfied with chromic catgut as it has worked out in cases of suture of the flexor tendons, and black silk is superior in that there is less local irritation.

DR. DAMON B. PFEIFFER said that almost everyone sutures tendons differently. The books describe a great variety of complicated sutures. The speaker has finally adopted a suture devised by Doctor Harmer, of Boston, which he finds very simple, consisting of whipping over the sides of the tendon and tying both ends. The other methods of suture described, seem to be very complicated. In the last few years there has been a great deal of emphasis laid on the necessity for a suture which will allow early mobilization. This case of Doctor Weeder's would seem to show that this is not as important as we have been led to believe, as his case was mobilized two weeks later, with good results.

DR. HUBLEY OWEN said that cases of severing of tendons and nerves are not uncommon in the Police and Fire Department. Often a wall falls down on the hands or wrists of a fireman while he is going up a ladder. There is a great deal of incapacity for active duty due to these injuries. Doctor Owen has been fortunate with his results in suturing the tendons, but not the nerves. The speaker showed before the Orthopædic Club, a man who while hunting, fell and cut the extensor tendons of the wrist. The tendons were sutured but apparently the tendons of the little finger and those of the fourth finger got mixed. Nature finally corrected the mistake after a few months and coördination was obtained.

DR. GEORGE M. DORRANCE said that he has seen a number of cases of primary suture which have later broken down. A number of years ago he gave up the primary suture, in cases where the wound might be infected, and used the secondary suture. He has had no reason to change his opinion. If the wound is presumably infected, he would rather clean it up first and

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later do the secondary suture. The speaker's results have been better than when he did primary suture in wounds which he knew were filled with dirt and might be infected.

### HERNIA INTO LESSER PERITONEAL CAVITY FOLLOWING GASTRO-ENTEROSTOMY

DR. CALVIN M. SMYTH, JR., reported the case history of a woman, aged sixty-one, who was admitted to the Methodist Episcopal Hospital on April 27, 1927, in the service of Dr. Damon B. Pfeiffer. For the past ten years she had suffered with pain in the epigastrium and vomiting. The pain was invariably worse after food had been taken, but was relieved by vomiting. The patient denied that the vomiting was ever induced and described it as being projectile in type. The pain was described as being "worse than labor pains". Occasionally there would be an abatement of symptoms for a few weeks, but never for longer than two months. Six years ago she was operated upon at which time she was told that her gall-bladder was drained and appendix removed. Following this operation she was somewhat improved for a period of one year, but for the past five years her symptoms had become progressively worse. Recently there had been an alternating constipation and diarrhoea; at times she would have as many as ten stools in a day and again the bowels would not move for three or four days at a time. She had had considerable gaseous distention. There had been no loss of weight. Apart from the operation, six years ago, the past history was negative, except for the passage of a tapeworm three years ago. Physical examination was essentially negative, except for the abdomen, which showed a moderate amount of distention and hyperperistalsis. There was vague tenderness over the entire right side, more prominent in the upper portion. The scar of the previous operation indicated that a right rectus incision had been made. No mass could be palpated. The usual examinations of blood, urine, faeces, gastric contents and the tests of kidney function were all within normal limits. Gastro-intestinal X-ray examination disclosed a dilated stomach which retained two-thirds of the opaque meal at the end of twenty-four hours. During the course of these studies the patient had two attacks of pain which were followed by vomiting of enormous quantities. Gastric and colonic lavage gave relief. A pre-operative diagnosis of chronic pyloric obstruction, probably benign, was made. At operation, May 6, on opening the abdomen the entire small intestine was markedly distended. In searching for the point of obstruction, it was found that the entire small bowel had herniated through an opening in the transverse mesocolon, passing into the lesser peritoneal cavity and in turn emerging through a second opening in the gastro-hepatic omentum, finally coming to lie in front of the stomach. After the "geography" of the situation had been worked out and the intestine restored to its normal relations, the upper abdomen was explored. There was no evidence of any operation having been done upon the gall-bladder; the stomach was tremendously dilated and there was a gastro-enterostomy located practically into the pylorus. The stoma was almost closed and showed the extensive induration characteristic of marginal ulcer. In view of the somewhat shocking procedure which the replacing of the intestines had entailed, it was thought unwise to subject the patient to gastric resection. A second posterior gastro-enterostomy was therefore made to the cardiac side of the existing one. Great care was observed in closing the defects in the mesocolon and the gastro-hepatic omentum. The patient made an uneventful recovery and was discharged from the hospital on May 27, 1927. She reported by letter in October, 1927, that she was quite well and entirely free

## REDUCTION "EN BLOC" OF STRANGULATED HERNIA

from the symptoms for which she sought relief. This case was reported on account of the very unusual nature of the hernia and as an illustration of the trouble which may arise from failure to close the opening in the gastro-colic omentum in the operation of gastro-enterostomy.

## REDUCTION "EN BLOC" OF STRANGULATED HERNIA

DR. CALVIN M. SMYTH, JR., reported the case of a woman aged thirty-one, who was admitted to the Methodist Episcopal Hospital on March 29, 1926. For the past five months she had noticed a swelling in the right groin which fluctuated in size and at times completely disappeared. The mass had at no time been painful or tender. On the evening of her admission to the hospital, the patient was seized with an acute colicky pain in the abdomen and at the same time the mass in the groin became larger and exquisitely tender. She felt nauseated but did not vomit. A physician who was called, diagnosed the condition as strangulated inguinal hernia and sent her to the hospital. He made no attempt to reduce the hernia by taxis. At the hospital she was examined shortly after admission but no mass could be demonstrated. Her temperature, pulse and respirations were normal and she complained of no pain. The following morning the patient wished to go home, but on further examination a mass the size of a hazelnut could be palpated in the groin. This was thought to be a gland, but on account of the previous history, she was advised to stay in the hospital for another twenty-four hours for observation. Thirty-six hours after admission the pulse rose to 130°, but the temperature remained normal. A blood count revealed 18,000 white blood-cells. She was seen by the reporter at this point. Doctor Smyth advised operative investigation of the mass. At operation on March 31, through an inguinal incision, the mass was exposed and was found to consist of a tab of pre-peritoneum fat which was protruding through the internal inguinal ring. On opening the peritoneum a foul odor was noticed and a finger introduced into the abdomen palpated a mass to the inner side of the ring. A piece of gauze was placed over the inguinal incision and the abdomen opened in the midline. A loop of ileum was delivered which proved to be completely gangrenous and was perforated at one point. A segment eight inches long was resected with the cautery and the continuity of the bowel restored by end-to-end anastomosis. A jejunostomy was made through a separate incision high in the left side and a catheter sewn in. The midline incision was closed without drainage; the inguinal incision was left open and the abdomen drained through this opening with two cigarette drains. The post-operative reaction was severe but the bowels moved normally on the fourth day. The drainage from the jejunostomy gave considerable trouble. The catheter came out on the fifth day but the opening continued to drain for seventeen days. This drainage was highly irritant to the skin, but excoriation was prevented by applying a thick paste of bismuth and zinc oxide. The drainage was removed from the inguinal incision on the sixth day and on the seventh day feces was discharged through the wound. The leak, however, must have been a small one, as drainage soon ceased and the wound was healed solidly at the end of the sixth week. The patient left the hospital at the end of the eighth week. She has been seen at regular intervals since and has had no trouble of any kind. In spite of the fact that the inguinal canal was never sutured in any way, there is no evidence of hernia. Doctor Smyth remarked that reduction "en bloc" is a comparatively rare accident. In the great majority of cases it follows an attempt at reduction by taxis. In this case as in a similar one reported to the Academy in 1926 by Dr. Stewart Rodman, no taxis had been employed. In a series of 137

cases reported from the literature by Comer and Howith, there was a mortality of 48 per cent.

## SPLENECTOMY FOR PERNICIOUS ANÆMIA

DR. SELLING BRILL, by invitation, presented a woman, aged fifty-seven, who was admitted to Doctor Stengel's service at the University of Pennsylvania Hospital, July 2, 1926, with the chief complaint of weakness. Her family and past history were irrelevant. She was a multipara. She did ordinary work of a housewife, and previous to the present illness slept well and followed an ordinary, well-regulated diet. The present illness began in April, 1925, when, following the death of her infant daughter, she became mentally depressed, and generally weak. She went to the seashore for six months to recuperate, but returned in October, 1925, unimproved. She remained in bed for six weeks. In March, 1926, she was sent to a local hospital for study. There she complained of vague abdominal pains, weakness, a peculiar feeling of her tongue, which she described as "a swelling", and a "pulling" feeling in her calf muscles. No numbness or tingling. Her temperature varied from 100 to 101°. For four months preceding entry to the University Hospital she had been mentally confused and grew weaker, and during the last four weeks she was confined to bed. Physical examination showed an elderly emaciated woman, constantly moaning and restless, very weak, with a peculiar lemon-yellow tint to the skin. She was dyspnoeic on any exertion. Mentally confused and disoriented, the conjunctiva were pale and had a lemon tint. She complained of buzzing in the ears. Cardio-vascular system essentially negative. The abdomen was essentially negative, except for a palpable, moderately enlarged spleen. The eyegrounds showed moderate hemorrhages in both fundi. Vibratory sensation decreased in both lower extremities, especially the right. Patellar and Achilles reflexes decreased.

*Clinical Pathology.*—Urine—16 examinations—ambre specific gravity 1003 to 1015, averaging 1010. Reaction acid, albumen faint trace. Sugar negative. Red blood-cells once—white cells few to loaded. Casts of all kinds on many occasions. Urobilin one on the one examination made. The phthalein test showed forty per cent. in two hours. Blood urea nitrogen 19 mg. per 100 c.c. Blood—in fourteen examinations the red count varied from 900,000 to 2,000,000; hæmoglobin 23 per cent. to 50 per cent., both higher figures were following transfusions. The color index at all times was one. The average of all blood counts 1,500,000 red blood-cells, average hæmoglobin 36 per cent., giving an average color index of 1.2. The white count varied from 2900 to 11,600—average 4800. The smear showed nothing unusual in the distribution of the neutrophils and lymphocytes. The differential count showed on the average of monocytes 3 per cent., eosinophiles 3 per cent., myelocytes 2 to 4 per cent., marked polychromatophilia, anisocytosis, poikilocytosis, macrocytosis; normoblasts 1 to 2 per cent., megaloblasts 1 to 5 per cent. Cabot ring bodies were noted twice. Reticulated reds 1.5 per cent. on one examination and 4 per cent. on another. The fragility test showed hæmolysis beginning at .450 and completed at .375. The Van den Bergh test was direct negative, indirect 3.2 units. Blood culture negative. Blood Wassermann negative. Bleeding time three and a half minutes, coagulation time five minutes (capillary method). Platelets 50,400 one examination. Fæces—six examinations—were made, of which four were positive for occult blood. All were positive for bile pigments.

Patient remained on the medical service until October 10, and had eight transfusions averaging from 200 to 500 c.c. She kept going steadily downhill

## SPLENECTOMY FOR PERNICIOUS ANÆMIA

and in view of the fact that the X-ray of the gastro-intestinal tract showed "constant constriction of the pyloric region due possibly to carcinoma", surgical consultation was asked for and laparotomy advised. At this time the patient weighed 88 pounds. She was transferred to the surgical service and operated upon by Dr. George P. Muller, October 16, 1926. The stomach, pylorus and duodenum disclosed no pathology. The gall-bladder was slightly thickened, contained two rather large stones and the spleen was found to be twice the normal size. After some discussion it was decided to remove both. Toward the end of the operation she was transfused—250 c.c. of blood by the citrate method. Closure in layers without drainage.

Pathological report of the gall-bladder showed a chronic interstitial cholecystitis. Pathological report of the spleen showed the usual hypertrophic change, but nothing of significance. The patient made an uneventful recovery and repeated examinations of the blood showed a steady improvement.

At the examination of the follow-up clinic in February of this year note was made that she was looking remarkably well, had gained over twenty-five pounds in weight, color was good, had regained strength, had good appetite and good digestion. She was seen again the following May and had gained another twenty-five pounds. She was last seen October 26, 1927, she weighed 149 pounds, had no soreness of the tongue, or paresthesias of the extremities. Physical examination showed no jaundice and a normal tongue. The blood examination at this time showed: Red blood-cells, 3,940,000; white blood-cells, 10,900; hæmoglobin, 96 per cent.; platelets, 272,000. Fragility test begins at .450, complete at .275. Reticulocytes 0.5 per cent. Van den Bergh direct negative, indirect 0.2. Clotting time ten minutes. Clot retraction normal. Cell volume, 47 per cent. Differential normoblasts, 50 per cent.; small lymphocytes, 31 per cent.; monocytes, 4.5 per cent.; eosinophiles, 3.5 per cent.; basophiles, .5 per cent. Smear—macrocytosis marked. Many Howel Jolly bodies. A few basic styppled macrocytes. No nucleated red cells. Some giant platelets. A gastric analysis had never been done because the patient had never been able to swallow a stomach tube. She has eaten about one pound of liver a week since discharge.

The reporter said that this was a fairly clear case of primary pernicious anæmia, although three things were lacking. More definite cord symptoms, a better history of glossitis, and gastric analysis. The diagnosis of hæmolytic ictero-anæmia was considered, but in this disease the anæmia is very rarely severe in the familial type, color index is usually low, microcytosis is the rule instead of macrocytosis as in this case. The finding of gall-stones is more in favor of the diagnosis of hæmolytic ictero-anæmia. From the present laboratory examination this patient still suggests primary pernicious anæmia. The color index is high, macrocytosis is marked. The cell volume is well above normal for women. In considering the excellent result there are three factors: the operative procedures, including splenectomy and cholecystectomy, and the liver diet that the patient had followed since discharge. The liver diet although definitely inadequate (Minot recommends at least 200 grams daily) has been sufficient quantity to have possible effect on pernicious anæmia. Patient said she has eaten one-half pound of liver twice a week, which amounts to an average of 60 to 70 grams daily. Splenectomy has been generally given up in pernicious anæmia. However, it has undoubtedly helped some cases of the hæmolytic type and is known to produce clinical cure of hæmolytic ictero-anæmia. The association of primary pernicious anæmia with chronic gall-bladder disease was first noted by Georgi in 1887. More recently, Jones and Joyce in two reports in 1924 and 1927 report 24 consecutive cases, 15 of undoubted pernicious anæmia and 7 of probable or

borderline anæmia, all complicated with gall-bladder disease, and the anæmia remarkably improved in several cases following cholecystectomy.

DR. GEORGE P. MULLER said that including the case reported by Doctor Brill, he had performed splenectomy eight times for pernicious anæmia. All of the cases recovered from operation. One patient lived twenty-three months but was given five transfusions—at irregular intervals. Four cases were not improved at all and died, two, three, seven and seven months respectively, after operation. One patient was operated upon in June, 1915, and eleven years later was under the speaker's care for an infection of the thumb complicated by diabetes. He can be considered as entirely cured of the pernicious anæmia and was undoubtedly case diagnosed by Doctor Stengel. Another patient had the splenectomy done in November, 1922. Five years later he reported himself well, but Doctor Muller found that his hæmoglobin was twenty-four per cent.; the red cells 1,370,000. The blood picture is that of pernicious anæmia. It will be interesting to note the effect of a "liver diet". While it is probable that splenectomy will now be performed less frequently, yet Griffin has recently (1927) stated that it is probable that splenectomy combined with other methods of treatment may eventually have a more significant place in the management of pernicious anæmia.

#### PLASTIC OF FACE AND JAW FOLLOWING EXCISION FOR CARCINOMA

DR. GEORGE P. MULLER reported the case of a patient who had a repair for a defect of the face and jaw following excision for carcinoma. The patient, forty-nine years of age, was referred by Dr. George Pfahler in June, 1923, suffering from an extensive carcinoma of the cheek with extension on to the alveolar process of the lower jaw. The X-ray shows erosion down to the level of the inferior dental canal. There is metastasis to the submaxillary lymph-nodes. Doctor Pfahler proposed destruction of the diseased area by electro-coagulation with dissection of the lymph-nodes and excision of the inferior maxilla. Preceding the operation he gave him treatment with the high voltage rays externally and surface applications of radium internally. On June 21, 1923, the operation was performed and included a bloc dissection of the neck upward from the omohyoid and removal of the entire lower jaw from about one inch from the symphysis backward. The electro-coagulation destroyed almost the entire cheek from the zygoma to the jaw and included the angle of the mouth. He was discharged on July 7, 1923, to report back to Doctor Pfahler for post-operative radiation treatment. On December 12, 1923, Doctor Pfahler reported a small area at the lower edge of the scar which looked suspicious. It was destroyed by electro-coagulation after a biopsy, but this showed evidence of recurrence. He was then given a dose of high-voltage X-rays. Shortly thereafter we began to think of ways and means to close the hole in the face. The first intention was to turn up the flap from the neck and cover the outer raw area with a second graft from the neck nourished through a Gilles tube. The first stage of this operation was done on February 11, 1924, but a few days later a flap of skin which had been turned up showed gangrene and ultimately sloughed away. A few weeks later a second Gilles tube was made and in April flaps were dissected corresponding in size to the opening in the cheek and were then sewed back into their place. A few weeks later they were again detached, the raw areas apposed, and both flaps buried into one of the sites in the neck. A week later, the flap faced on both sides with skin and connected by two Gilles

## COLONIC ANÆSTHESIA IN OPERATIONS UPON THE BRAIN

tubes, was sutured into the defect in the face. The flap healed pretty well and the patient was sent away for the summer. In October, 1924, and subsequently through 1925 a succession of small plastics was done until all holes leading into the mouth were sealed up, except that a communication above with the edge of the superior maxilla could not be closed owing to osteitis of bone. At no time has there been any evidence of recurrent malignant disease and to-day, about four and a half years after the primary removal, he seems free of malignancy.

## COLONIC ANÆSTHESIA IN OPERATIONS UPON THE BRAIN AND SPINAL CORD

DR. CHARLES H. FRAZIER read a paper with the above title, for which see page 161.

DR. FRANCIS C. GRANT said that in Doctor Frazier's absence this past summer, he used colonic anæsthesia, particularly in laminectomies and where he was doing rhizotomy for pain in the mouth and neck following carcinoma of the jaw and neck and in which we did not want to give anæsthesia by mouth on account of the slough carried into the oral cavity. He used the technic which Doctor Frazier outlined and it proved to be very satisfactory. Of course the pre-operative preparation seems very elaborate and that technic should be carefully followed in order to get the best results. Doctor Grant thought that the procedure did not lend itself to general surgery, because of the necessity of speed in handling a number of cases. All the neurological surgeon expects it to do is to keep the patient quite still and it will accomplish that. Where a major procedure is being carried out under local anæsthesia, often the patient will start to fret and the pulse goes up and one must resort to ether. There is no such difficulty with colonic anæsthesia. There is only one objection that the speaker has and that is when one needs enteroclysis given on the table.

DR. ROBERT IVY remarked that he reported to the Academy in 1926 the results in the use of colonic anæsthesia in 30 or 40 cases of operation about the face and head and he believes that this is the ideal method of anæsthesia in cases taking longer than one hour, because the anæsthetizing apparatus is always away from the parts being operated upon. In addition there are the advantages which Doctor Frazier has outlined. For shorter operations, the amount of preparation necessary for colonic anæsthesia does not make it worth the trouble. The speaker has found that the results are better with women patients than with men; he thinks that this is due to the fact that the male patients are prepared by orderlies and are not prepared as thoroughly and carefully as are the women patients, who have the care of nurses.

## BRIEF COMMUNICATIONS

### ACUTE INTUSSUSCEPTION IN INFANTS

In the following paragraphs, which are a part of a paper on the subject of acute intussusception in infants read by me before the Southern Surgical Association in December last, I present my personal experience.

The present series comprises twenty-five consecutive cases, with twenty-five operations and one spontaneous reduction of the intussusception. In one case, an infant of six months, was re-operated on for a recurrent ileo-colic intussusception three months after the first operation. He has since remained well. Though comparatively small, this series presents many of the vagaries of this strange disease. All but three were under one year of age, the oldest was seven years, the youngest three months. Out of the entire series, there were only six females. The majority of the intussusceptions were of the typical ileo-colic type. There were two purely enteric intussusceptions, a baby of three months and a child of seven years, in both of whom resection of terminal ileum was done for gangrene, with death in each case. A Meckel's diverticulum was the cause in a girl of four years, in whom resection was done, followed by death. There were two cases of compound intussusception, one in a baby of four months and the other in a child of three years and three months. After the mass in the colon had been reduced, there was still an intussusception of the small bowel with the apex in the cæcum and colon. Both infants had a quiet convalescence.

Of the twenty-five operations, there were seven deaths, an operative mortality of 28 per cent. Of these seven deaths, there were five resections, which means that the diagnosis or the institution of surgical treatment was too long delayed in five cases. One of the other two fatal cases was a male baby of eight and a half months which had been ill for three or four weeks with ileo-colitis and in whom the occurrence of an ileo-colic intussusception was a complication of this already grave disease. He died about twelve hours after operative reduction of the intussusception. In the other case, although reduction was not difficult, the baby did not survive the operation many hours. There seemed to be an unusual degree of toxæmia present. These details therefore obviously indicate that in the uncomplicated case of intussusception, if operative reduction is promptly done, the mortality rate may be greatly lowered. The problem then would seem that of prompt diagnosis.

Of the patients who recovered, there are found a number of facts perhaps worthy of note. There was one negro, eight and a half months, in the series. In a baby of eight months, while under examination, he strained and forced the apex of the intussusception about three inches to the outside of the anus. This was promptly replaced, an immediate operative reduction performed, and the infant went on to an uneventful convalescence.

In the whole series the only symptom that was constantly present was the periodic paroxysms of abdominal pain, abrupt in onset, usually associated



## ABDUCTION TREATMENT FOR FRACTURE OF FEMUR

with evidences of shock, as indicated by the striking pallor and rapid pulse, and soon followed by reflex vomiting. The appearance of blood and mucous in the stools was a variable symptom. There were five instances in this series in which there was no blood passed by bowel. Fever was usually present, although in the early stages it was absent. In all but five of our cases the temperature was over 101 on admission to the hospital. The finding of a tumor has not always been possible. In one of our cases the tumor was not felt on first examination but two hours later it was distinct, which brings out the value of repeated examinations at short intervals in a suspicious case.

In one instance the tumor could be palpated only by rectum, in another the outlines of the mass could be seen on the abdominal wall in a well-nourished baby and was lying transversely across the epigastrium. In five cases the tumor was not palpated at all, in a sixth was doubtful, and in another only under anæsthesia. It is in these cases that the barium enema and fluoroscopic examination are of the greatest help, particularly when corroborated by suggestive symptoms.

Marked distention of the abdomen was present only in six cases, and was moderate in a seventh. These are the seven fatal cases, and it may therefore be considered of very ominous import. Presumably this is present only when obstruction of the bowel develops and is a late manifestation.

Fluoroscopic examination after a barium enema was used seven times in the series, although we have made much more frequent use of it in suspected and unproven cases. In each of these seven instances, it gave positive results. Occasionally we have been able to get a plate which gives a beautiful representation of the apex in the bowel lumen. Usually the baby promptly expels the barium before this can be done. In one baby this method of diagnosis was very helpful. It was an early and quite doubtful case, the pain was not as severe as is usual, the tumor could not be felt, and there was no discharge of blood and mucous from the rectum. The tumor was found at operation much as has been indicated by the fluoroscope, high up beneath the liver in the right side.

The earliest operation of the series was seven hours after onset and the longest five days.

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## THE ABDUCTION TREATMENT FOR FRACTURE OF THE NECK OF THE FEMUR

I have read with interest Doctor Moore's paper in the last issue of the *ANNALS OF SURGERY*, in which he describes the abduction treatment for fracture of the neck of the femur applied in flexion instead of extension. The purpose of the modification is to permit the assumption of the sitting posture immediately after the application of the plaster spica. It was originally devised for aged patients but the author apparently employs it at the present time in all cases.

From this standpoint the paper is of especial interest because it is now generally admitted that fracture of the neck of the femur may be treated like

## BRIEF COMMUNICATIONS

other fractures, and since such treatment has been made practicable by the abduction method the question at issue is of its proper application.

Granting that the mechanism of the hip-joint may be utilized as effectively in flexion as in extension, what may be called the orthodox method, namely: fixation of the limb in full abduction, full (hyper) extension and slight inward rotation has, in comparison, the following advantages:

1. The effectiveness of the abduction method in restoring the normal relations of the injured part is confirmed by an exact correspondence of the anatomical landmarks on the two sides, a comparison possible only when the limbs are in the same relation to the pelvis.

2. The application of the method, including the adjustment of the plaster spica is, by comparison with that described by Doctor Moore, very simple, requiring only a secure pelvic support with a perineal bar against which manual traction on the extended limbs may be exerted.

3. The attitude of complete extension forces the fragments forward and thus checks the tendency to displacement in the cases, in which there is disintegration of tissue, preliminary to repair.

4. Complete extension assures the normal lumbar lordosis and lessens the pressure on the sacrum.

5. The extended attitude permits the alternation of the dorsal and ventral attitudes in recumbency, a most important element in the treatment.

The only question, therefore, is whether the possible advantage of the sitting posture for the patient will counterbalance its manifest disadvantages as concerns the fracture. From my own experience I conclude that the danger of bed treatment has been greatly exaggerated. Under former conditions patients with broken hips died because of pain, infected bed sores and mental and physical depression, not because they lay in bed.

At the present time the elevation of the head of the bed, the frequent changes of posture, the transportation to the open air, the freedom from pain and the expectation of recovery have practically eliminated the danger of treatment.

In the rather extensive bibliography appended to the paper the only reference to my work is to a paper published in 1921. The abduction treatment was described in detail in the *ANNALS OF SURGERY* for January, 1925, to which those who may be interested in the comparative merits of the original and modified methods are referred.

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## THE TREATMENT OF COMPOUND INJURIES OF THE EXTREMITIES\*

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IN THIS age of mechanical industry and automobiles, hazards are great and accidents are many. Occupational injuries, it seems, are decreasing gradually, due, in great part, to the installation of safety devices, and also



FIG. 1.—Case No. I described in the text, showing the wounds three days after operation, and at the end of one year.



FIG. 2.—See figure 1.

to educational propaganda among the workmen by means of lectures, posters, etc. Injuries caused by motor vehicles are probably on the increase, as evi-

\* Read before the Section of Surgery of the New York Academy of Medicine, November 4, 1927.

denced by recent statistics. The total number, augmented by accidental injuries received in other ways, is appalling when statistics covering large sections of the United States are analyzed. While, undoubtedly, the future will bring methods for decreasing the number of accidents, the situation at the present time must be met by the intelligent treatment of these injuries so that there

will be a saving of life and limb with return of form and function as near to normal as possible.

The writing of this paper was undertaken with the idea of presenting our experiences with the treatment of many varieties of injuries of the extremities, indicating the type of therapy that has given satisfactory results and citing cases illustrating points to be particularly emphasized. The cases forming the basis of this communication were patients on the second surgical division of the New York Hospital, which, by its geographical situation and by reason of its ambulance service, draws patients from factories, railroad yards, street accidents, etc.

The recent war taught a number of important lessons, and it is partly the purpose of this paper to emphasize again the practice and teaching of

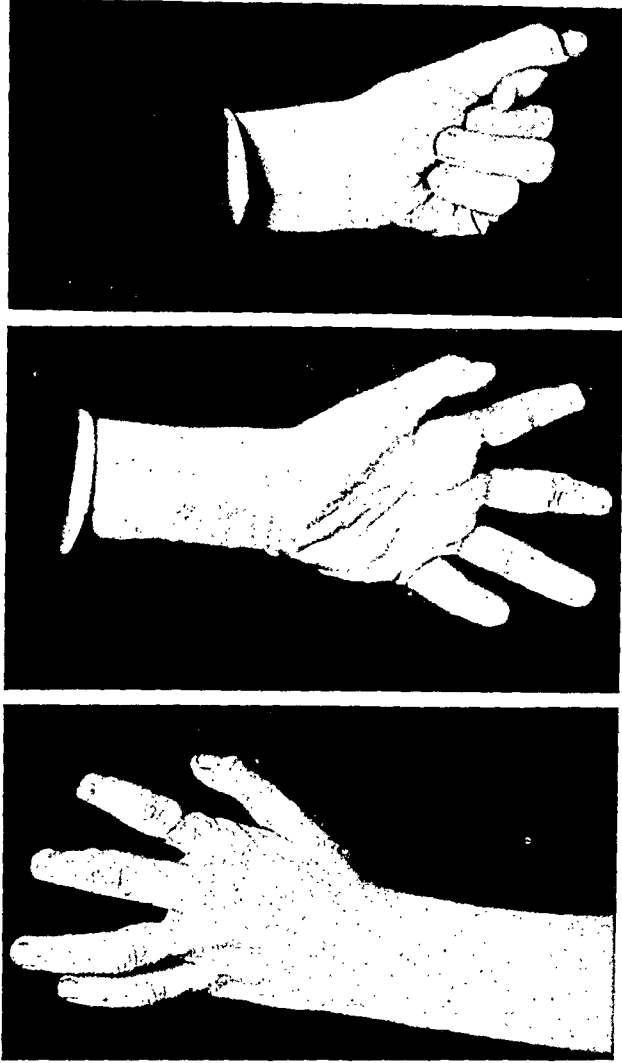


FIG. 3.—See figure 1.

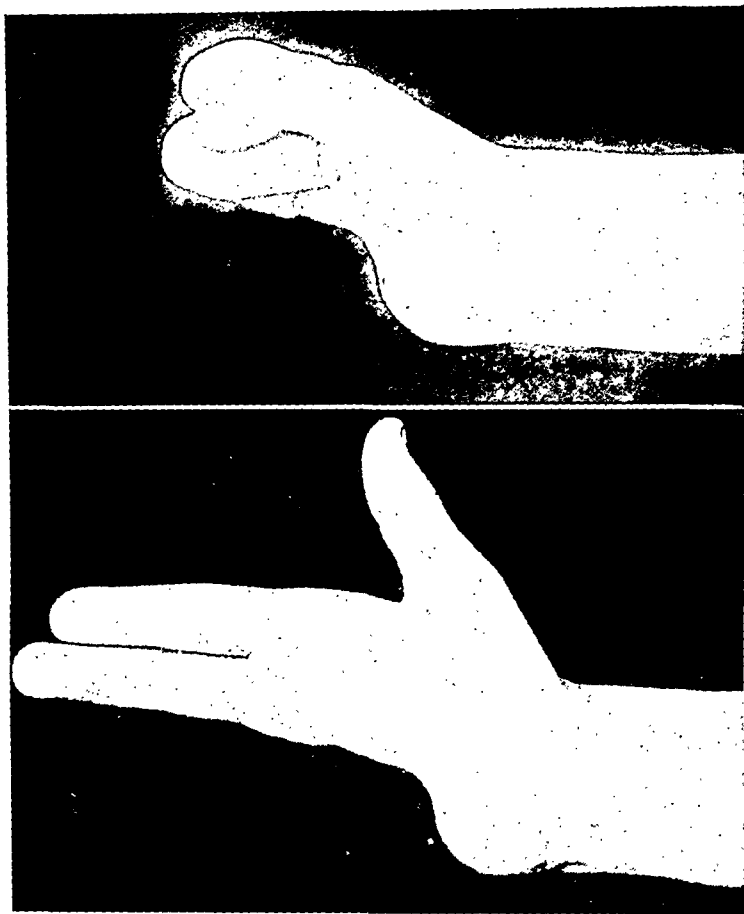
surgeons at its termination. While some of the principles had been advocated many years ago and were used sporadically, experiences during the war brought them forcibly to the attention of surgeons with a consequent more general adoption. Thus, Lucas-Championnière, many years ago, championed the cause of early active motion in the treatment of fractures. Mechanical cleansing of wounds by irrigation is an old principle, as is also that of débridement.† While, during the war, these procedures received general adoption, there has since been some reluctance on the part of many surgeons to make use of these measures in civil surgery. The reason for this is not

† The word "débridement" is used in the sense of "wound excision".

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

clear. We, therefore, feel it sufficiently important to review the details and urge their adoption.

To attain the ideal above alluded to, the first step is the organization of a service in each hospital treating surgical patients, which will be under the direct supervision of one or more surgeons, especially interested in this type of work. This does not imply that these men need necessarily confine their work to this particular field, but it does predicate that their previous training has been sound and that their interest is keen. Secondly, the necessity of considering these patients as emergencies and treating them as such is apparent. The practice of postponing until the following day, the surgical treatment of a patient injured at night, is inexcusable and will soon demonstrate its inadvisability by the results obtained. Finally, when the principle of débridement, combined with that of irrigation of wounds becomes universally accepted as the basis of initial treatment of these cases, a marked improvement in results may be expected. Along



FIGS. 4 and 5.—Case No. II reported in the text, shows the final result at the end of eighteen months. The patient has a very serviceable hand.

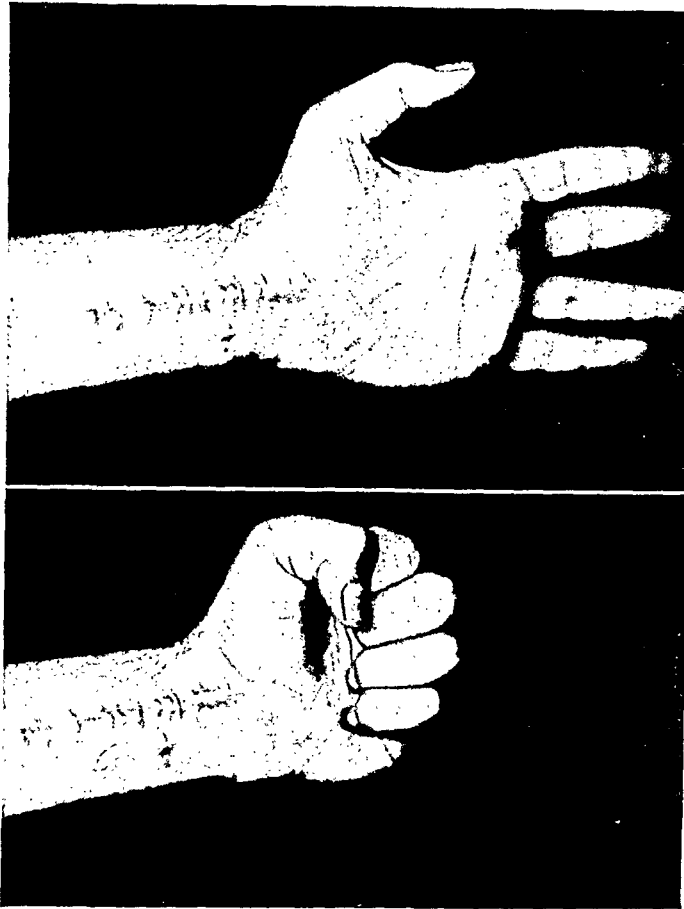
with this, must be accepted the principle of early active motion, especially indicated in joint and tendon injuries and in a selected group of compound fractures.

### WOUNDS OF SOFT PARTS

In uncomplicated wounds of the soft parts, the ideal treatment consists in a thorough débridement, after the preliminary preparation to be outlined later, followed by primary suture without drainage. The results obtained have more than justified the additional expenditure of time and effort. The fine scar, the lack of deep scar tissue formation, the accurate approximation of anatomical structures and the rapid return of function are outstanding reasons for the recommended procedure. With smaller wounds, such treatment is not always feasible. Under these circumstances, a careful cleansing, proper iodination, complete hæmostasis, and the insertion of a minimum

number of skin sutures will usually result in satisfactory healing. This brings up the question of lacerated wounds of the hand. Because of its manifold functions, its constant exposure and resultant multitudinous bacterial flora, the hand is peculiarly susceptible to infection. In addition, it must be remembered that because of its anatomical construction with the various

bursæ, tendon sheaths, and closed spaces, the hand is particularly prone to infections resulting in serious disabilities. The writer is firmly convinced that, just as soon as the general practice of suturing lacerated wounds of the hand without drainage and without regard for the elementary principle of tension of tissues is stopped, the general incidence of hand infections will rapidly decline. The above statement applies solely to the practice of suturing without preliminary cleansing and débridement. In hand wounds of any magnitude, it is imperative that the patient be anesthetized and a careful cleansing and débridement be done. Following such therapy, it is



FIGS. 6 and 7.—This patient, age sixteen years, was operated upon July 26, 1927, eight hours after the receipt of an injury produced by the fender of an automobile. The structures found divided were: Flexor longus pollicis, flexor sublimus and profundus tendons of the index and middle fingers, and the median nerve. The tendons were repaired by the technic described in a previous communication (ANNALS OF SURGERY, January, 1927). The nerve was repaired by six, perineural sutures of fine silk. Photographs indicate the result at the end of two months.

safe to suture the wounds loosely, avoiding undue tension and limiting the number of sutures to a minimum. When such a procedure cannot be carried out, cleansing, iodination and the insertion of one or at the most, two, sutures, or the application of a few sterile narrow adhesive strips, should constitute the extent of treatment.

CASE I.—J. D., seven years of age. Admitted January 8, 1927, discharged January 18, 1927. Just before admission, this patient was playing with a toy gun. He placed a .45-calibre rifle cartridge in the gun, and tried to fire it. As the cartridge was too long to fit in the barrel of the gun, the patient held it in his left hand and pulled the trigger. The cartridge exploded into the palm of the left hand.

Examination showed that the thumb was almost completely avulsed at the carpo-

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

metacarpal joint. There was an irregularly shaped laceration along the adduction crease extending around to the dorsum of the hand. The thenar muscles were pulpified. The flexor sheath of the thumb was open, but the tendon appeared intact. The first dorsal interosseous muscle was divided and crushed. The carpo-metacarpal joint was exposed, and its capsule was practically completely divided. No nerves were visible. There were numerous lacerations on the thumb, one of them exposing the distal joint. The index finger was partially amputated through the middle of the distal phalanx. A flap of skin had been avulsed from the proximal phalanx of the index finger, but remained attached by a broad base anteriorly. The middle finger was partially amputated through the middle of the distal phalanx.

Operation consisted of the usual preparation followed by a complete débridement. Remains of the various muscles were sutured by fine catgut. All joint capsules were closed. The skin flap on the index finger was sutured back in place. The amputated ends of the index and middle fingers were débrided and left wide open. The wound in the palm was closed without drainage. There was no elevation of temperature or pulse, and all wounds were healed within three weeks without evidence of infection. A course of baking and massage was given.

Now, ten months later, all wounds are healed and there is normal motion in the fingers. Because of the loss of the thenar muscles, there is considerable impairment of adduction of the thumb. (See Figs. 1, 2 and 3.)

CASE II.—W. K., nineteen years old. Admitted March 12, 1926, discharged March 20, 1926. A few minutes before admission to the New York Hospital, this patient injured his right hand, when it caught in an elevator.

Operation was performed immediately. There was almost complete amputation of the ring and little fingers as far back as the carpo-metacarpal joints. These avulsed tissues were black. The interossei and lumbrical muscles, the flexor tendons of the middle finger, and the extensor tendons of the index and middle fingers were exposed. There was marked traumatization of the muscle tissue of the hand in this region. The cartilaginous surface of the unciform and the shaft of the middle metacarpal were exposed. The usual preparation was given and complete débridement was performed,



FIG. 8.—Photographs of the end result, and the X-ray findings on Case No. III, described in the text. It is interesting to note that there has been partial regeneration of the internal condyle and the internal malleolus.

amputating the two inner fingers as far back as the metacarpocarpal joints. The cartilage on the articular surface of the unciform was excised. The wound was closed with a few interrupted silkworm sutures without drainage. The wound healed by primary union.

Now, eighteen months later, the scar is not tender and the patient has a very useful hand. (See Figs. 4 and 5.)

When, in addition to the wound of the soft parts, an injury to the tendons also exists, the picture becomes complicated and its solution will depend



FIG. 9.—See figure 8.

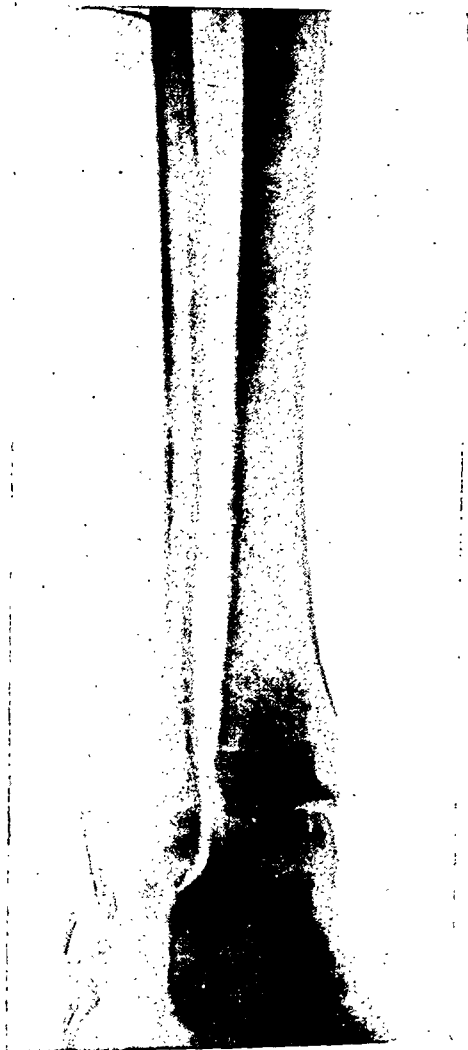


FIG. 10.—See figure 8.

more on the past experiences of the surgeon in similar instances than upon some text-book rule. It has been the writer's experience that wounds of the extensor tendons do well when sutured at the primary operation. In the great majority of instances, there is return of full function. When the injury involves the flexor tendons, an altogether different problem arises. In a previous communication (see *ANNALS OF SURGERY*, January, 1926), this question was discussed; what was said then, can again be repeated: "In the presence of a clean incised wound within twelve hours of the injury, imme-



## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

diate tenorrhaphy can be done with safety, after appropriate cleansing. When the wound is ragged and dirty, obviously grossly contaminated, and the surrounding skin is covered with grime and dried blood, it is the writer's opinion that the tenorrhaphy should be deferred until the wound has healed, the immediate interference consisting solely of a general cleansing and débridement. This delay of two or three weeks has not given rise to any great increase in fibrosis or adhesion formation, nor has it rendered the secondary repair very much more difficult." (See Figs. 6 and 7.)

When the more extensive wounds involve muscles and fascia, the necessity of thorough dé-

bridement becomes imperative. Traumatized muscle is an excellent culture medium and anaërobes, always to be considered in compound injuries, grow best in such a medium. The obvious method of decreasing the possibility of this or any other infection is to remove surgically all traumatized muscle and fascia. In the very severe injuries, especially of the legs,

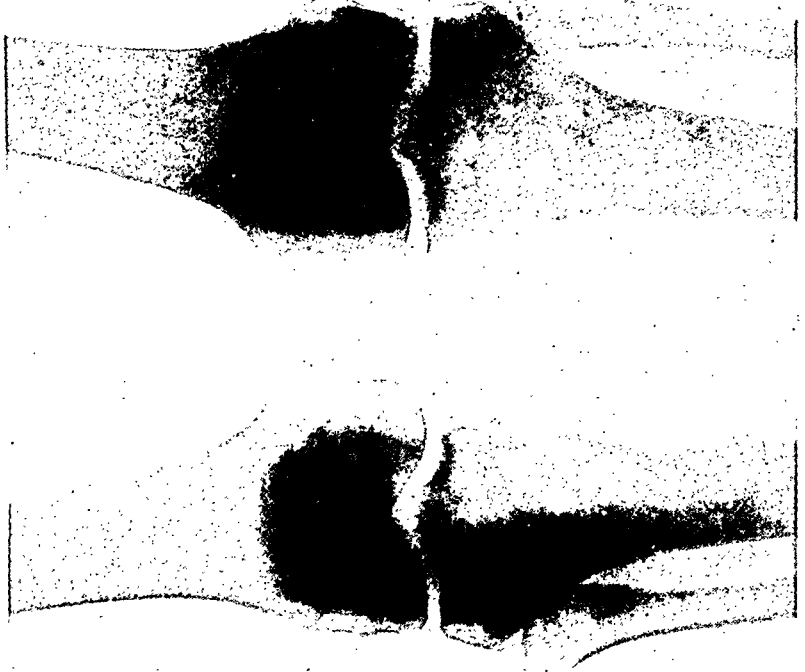


FIG. 11.—See figure 8.

following automobile accidents, this will often entail the sacrifice of a considerable part of the muscle tissue of an extremity. Even then, a gas bacillus infection may supervene, necessitating amputation. Conservation of limb should be the prime consideration, when possible; but it must be disregarded when conservation of life becomes the main issue. All damaged muscle and fascia is, therefore, excised by sharp dissection, the extent of this removal being gauged by the contractility and appearance of the muscle. Every effort should be made to preserve the main blood supply and all the motor nerves.

Considerable importance attaches to the advisability of closing such wounds. No hard and fast rules can be made, inasmuch as the former experiences of the surgeon will be the largest factor in determining what to do. Certain generalizations can be made:

I. It seems inadvisable to bury too much suture material in an attempt to coapt various muscle and fascial planes.

II. Hæmostasis must be complete.

III. Every effort should be made to avoid tissue tension in the placing of sutures, whether deep or in the skin.

IV. Probably the majority of these wounds can be closed without drainage and a primary union will result.

V. When the wound is accompanied by marked crushing of muscle tissue, it is probably better to close the wound only partially, at the same time insuring adequate drainage.

VI. In closing the skin, the use of too many sutures

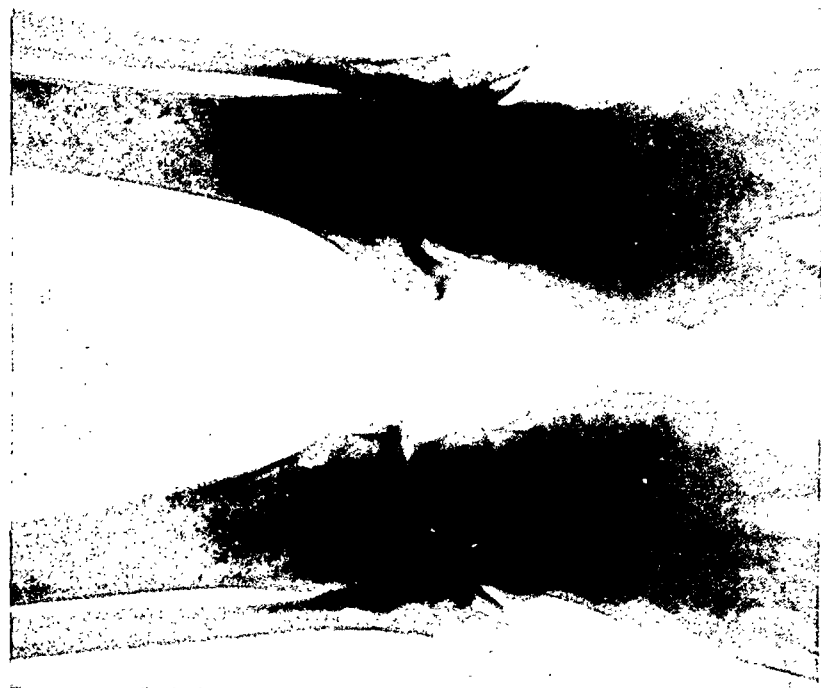


FIG. 12.—See figure 8.

should be avoided, emphasizing again the importance of preventing the tissue tension.

VII. Finally, and most important, if the history of the injury indicates

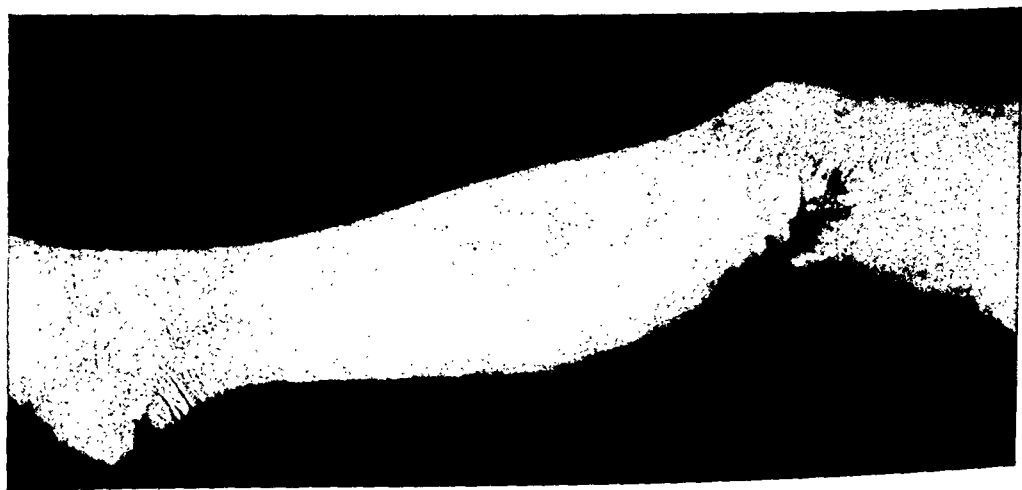


FIG. 13.—Photographs and X-rays of Case No. IV described in the text. The X-rays were taken immediately before and twenty-four hours after operation. Photograph indicates the result at the end of eighteen months.

a strong possibility of implantation of anaërobes, it is probably wiser to leave the wound wide open and later do a secondary suture.

Lacerations or compound fractures involving joints are not infrequent.

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

The finger-joints are more prone to such injuries and are therefore more commonly encountered. The knee, ankle and elbow-joints follow in order of frequency. A joint that has been opened by an injury does not always become infected. If one fears to close a joint because of the likelihood of infection, leaving it open is sure to invite infection. Therefore, provided



FIG. 14.—See figure 13.



FIG. 15.—See figure 13.

the capsule can be brought together, after débridement, without very great tension, immediate closure of the joint seems preferable.

Given a case with a traumatic wound opening into a joint, the following procedure is carefully carried out. This is our routine treatment for all compound injuries. After the patient is anesthetized, the whole region involved and a wide area of surrounding skin is shaved and carefully and gently scrubbed with sterile soft brushes and tincture of green soap. The soap suds and débris are washed away with sterile saline, care being taken to prevent the washings from entering the wound. The limb is then dried with sterile towels, followed by a wash with benzine. A copious irrigation

with ether then follows. The wound and surrounding skin is then mechanically cleansed by a prolonged irrigation with sterile saline. The parts are then thoroughly dried and again flooded with ether. The entire area, skin and wound, is then painted with  $3\frac{1}{2}$  per cent. alcoholic solution of iodine, care being taken to keep the iodine from synovial membranes, such as in a joint or tendon sheath. The extremity is then draped. Cultures are taken



FIG. 16.—See figure 13.



FIG. 17.—See figure 13.

from the depths of the wound and also from the surrounding skin. They should be so planted as to demonstrate anaërobics, if present.

A painstaking débridement of all traumatized skin and deeper tissues is then performed. The importance of handling the tissues around such wounds with the greatest care cannot be over-emphasized. To accomplish this, instruments must be sharp, dissection must be clean and rapid, sponging must be gentle, retraction intelligent and unnecessary puttering must be avoided. The importance of obtaining absolute hæmostasis should be realized. The wound and joint are now flooded again with ether and closure is

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

then performed. An accurate repair of the joint capsule is very desirable and can be accomplished by the insertion of mattress sutures of chromic catgut. Frequently this cannot be done without undue tension. Under such circumstances, one or two sutures at important points will favor early repair, providing the skin is closed over it. If definite layers of fascia are discernable, they should be repaired with a few interrupted sutures. The skin is sutured with interrupted silkworm gut. If skin tension is evident, releasing incisions in the skin flaps can be made. We have found this step of considerable importance. Either before or after operation, the patient is given 1500 units of tetanis antitoxin. This is routine.

Injuries to finger joints are nearly always accompanied by laceration of the superimposed extensor tendon. This must be repaired at the same time. Ankle-joint injuries are difficult cases to repair satisfactorily and end-results are not as brilliant as with other joints. Partial closure of the joint with complete suture of the skin is all one can hope to accomplish. Injury to the articular cartilage of a joint should be disregarded at the time of operation.

CASE III.—G. K., age thirty-five. Admitted February 18, 1926, discharged March 18, 1926. This patient received an injury to the right leg when it was caught in the revolving blades of a washing machine which he was repairing. He was admitted to the New York Hospital, and operated

upon immediately. At operation, there were found multiple lacerations of the leg. There was a transverse laceration at the inner aspect of the knee-joint which was wide open. The internal tuberosity of the tibia had been removed in an oblique manner at the time of accident, along with about two-thirds of the internal meniscus. There was another laceration at the inner aspect of the ankle-joint exposing the joint proper. The internal malleolus was missing. There were numerous lacerations of the leg proper, exposing the tibia for a distance of three or four inches. After the usual preparation, a thorough débridement was done. The capsule of the knee-joint was repaired with chromic catgut, and all the wounds were closed without drainage. Active motion was started on the third post-operative day. The patient was allowed out of bed on the eighteenth day and discharged a month later to the out-patient department where he received a prolonged course of baking and massage.

At the present time, as indicated in the photographs, motion in both joints is normal and there is no instability. Subsequent X-rays indicate partial regeneration of the upper and lower ends of the tibia, an interesting finding. (See Figs. 8-12.)

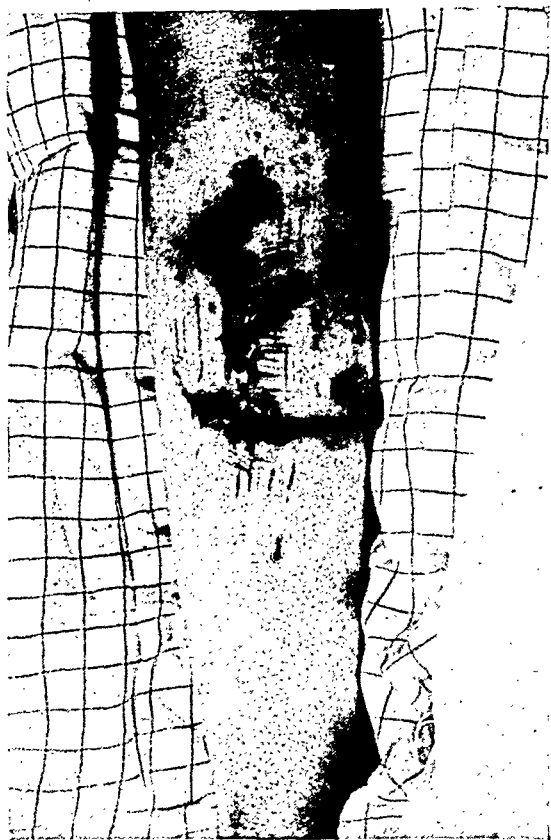


FIG. 18.—Photograph and X-rays of Case No. V described in the text. The photograph indicates the wound at the end of twenty-eight days.



FIG. 20.—See figure 18.



FIG. 19.—See figure 18.

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

CASE IV.—P. M., age five. Admitted March 22, 1926, discharged May 25, 1926. About half an hour before admission to the New York Hospital, this patient was struck by a truck, one wheel of which passed over his right leg.

Operation was performed within an hour. Along the inner side of the right knee was an irregularly shaped laceration, opening into the knee-joint. The soft parts showed considerable crushing. There was another irregular laceration over the middle of the tibia with crushing of the skin and muscles and a compound fracture of the tibia. After the usual preparation, a thorough débridement was performed. The knee-joint capsule was closed with interrupted chromic catgut, and the skin sutured with interrupted silk-worm gut without drainage. The leg wound was treated in the same way after a large hæmatoma was excised from the muscle planes and all traumatized muscle had been removed. The fracture was reduced and held in position by a circular strand of kangaroo tendon. The leg from toes to mid-thigh was encased in a plaster cast. Convalescence was uneventful. The wounds were inspected through windows cut in the cast and were soon healed by primary union. About four weeks later, the patient was taken to the operating room and a posterior moulded splint applied, placing the knee at 45° flexion. This patient received no physiotherapy.

End-result is indicated in accompanying photographs. (See Figs. 13-17.)

The period of immobilization following operation varies with each case, depending upon the extent of the injury, the extent of closure of the capsule, and the presence of associated injuries, such as fractures. In general, the earlier active motion

is started, the better will be the end-result. This applies particularly to the knee, elbow and ankle. Finger-joints with tendon suture require longer immobilization, approximately twelve to fourteen days. In uncomplicated ankle, knee or elbow injuries, active motion should be started on the second or third post-operative day. The range of motion will increase from day to day. Forcible attempts at passive motion should be strictly avoided. Weight bearing is permissible after eight to ten weeks.



FIG. 21.—Case No. VII described in the text. X-rays before and after operation. Photographs indicate the granulating wound before and after skin graft.

### COMPOUND FRACTURES AND DISLOCATIONS

All fractures compounded from without inward should be subjected to the operation of débridement following the cleansing above outlined. We feel that this admits of no argument. The majority of fractures compounded from within outward can be treated as simple fractures with very little, if any, danger. If, as occasionally occurs, the soft part wound is larger than

the usual puncture wound and a large section of the fractured end has protruded, then operation is indicated.

Very frequently these patients, upon admission to the hospital, are in shock. This must be treated before operation is attempted, the indication for proceeding being an improvement in the quality and rate of the pulse and elevation of the systolic blood-pressure to 100 mm. or over. Frequent use



FIG. 22.—See figure 21.

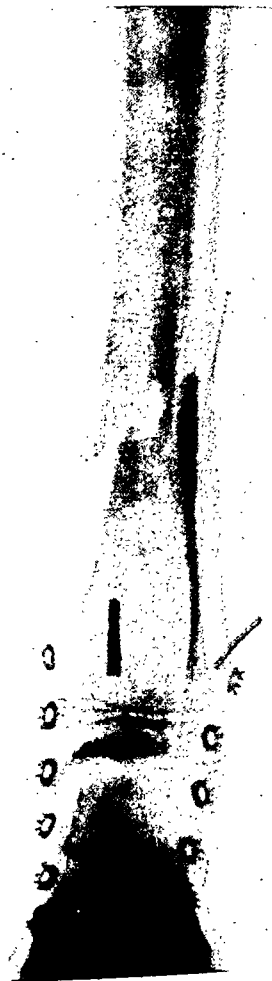


FIG. 23.—See figure 21.

has been made of the intravenous glucose insulin therapy, recommended by Fisher, with fairly satisfactory results. It is often necessary to wait three or four hours before operation can be attempted.

At operation, a very thorough débridement is performed. Adequate exposure is obtained by making a longitudinal incision over the site of injury. The formation of hæmatomata between and in muscles is a more frequent occurrence with compound fractures than with any other compound injury. These must be evacuated, as they form the best culture media for anaërobic organisms. All loose unattached bone fragments should be removed. It is inadvisable to remove too much periosteum. The ends of the bone should be removed with rongeurs and so fashioned as to form a mortise, whenever



# TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

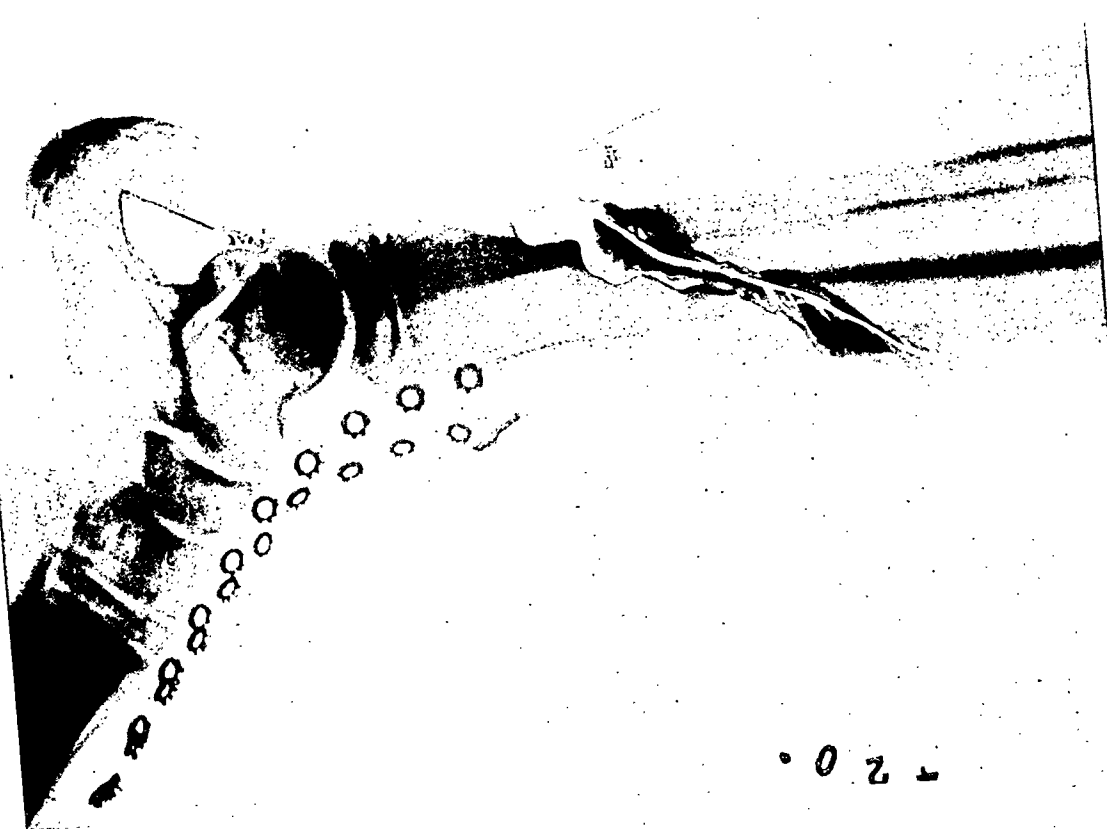


FIG. 24.—See figure 21.

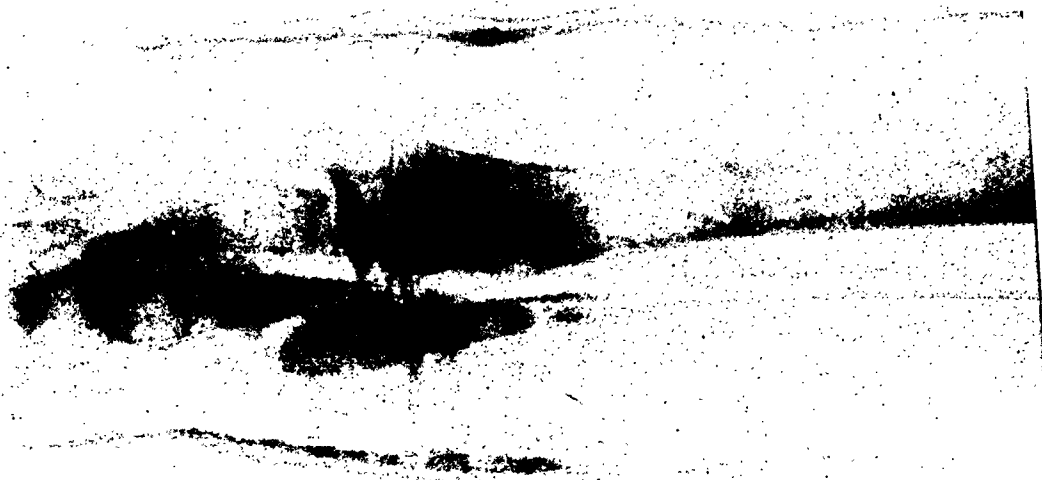


FIG. 25.—See figure 21.

possible. Transverse fractures, when reduced, usually lock satisfactorily and require no internal fixation. Oblique and spiral fractures, because of a tendency to displacement of the fragments, require some form of fixation. Our limited experience with Lane and Sherman plates has been distinctly unsatisfactory in this type of case. Main reliance has been placed upon the use of kangaroo tendon sutures placed around the bone and, also, obliquely through the bone through drill holes. This method has been particularly

satisfactory in compound fractures of the tibia, humerus, radius and ulna. We have always been reluctant to insert foreign material in the form of metal plates and screws, in the treatment of compound fractures. Occasionally, it is necessary to do so, as in certain types of femur injuries and in other fractures with loss of substance. However, the majority of the femur fractures have been treated by débridement followed by traction and suspension.

CASE V.—R. B., eighteen years old. Admitted December 8, 1926, discharged February 12, 1927. One hour before admission to the New




FIG. 26.—See figure 21.

York Hospital, this patient was hit by a taxicab, the bumper of which pinned the patient's right leg against an elevator pillar. Physical examination showed considerable shock, which was controlled by an infusion of 500 c.c. of glucose and 20 units of insulin, given according to the Fisher method.

Operation was performed four hours after admission. The usual preparation was given. There were two transverse lacerated wounds over the front of the tibia through which were seen the fractured ends of the tibia. A longitudinal incision was made connecting the two lacerations. There was considerable traumatized muscle and fascia. All traumatized tissue was carefully excised, including several small loose fragments of bone. To maintain reduction of the fracture, four drill holes were made and two kangaroo tendon structures were placed at right angles to each other. The wounds were then closed without drainage, using interrupted chromic for the skin. Circular cast was applied. The wound was inspected daily through a window cut in the cast, and it healed by primary union. Temperature and pulse remained normal. On January 17, on removal of the cast, on the lateral aspect of the leg, was seen an area  $4 \times 2\frac{1}{2}$  inches which was covered with slough. This apparently marked the point where con-

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

siderable trauma had been received at the time of accident. The slough was removed and the wound was dakinized. On January 26, numerous small deep grafts were applied. Upon discharge from the hospital, all wounds were healed.

Now, one year later, union is firm, there is no shortening, and no limp. (See Figs. 18-20.)

CASE VI.—J. B., seven years of age. Admitted October 30, 1926, discharged November 27, 1926. While sitting in the door of a dumbwaiter shaft, this patient was injured when the rope broke and the dumbwaiter fell two stories. The force of the impact was received on the right leg. The patient was admitted to the Second Surgical Division of the New York Hospital soon afterwards. Examination showed moderate shock. At the middle of the right tibia was an irregularly shaped longitudinal wound, four inches in length, through which the ends of the fractured tibia protruded. There was considerable crushing of the muscles and fascia.

At operation, performed two hours later, the usual preparation was given. An irregular transverse fracture of the tibia with considerable crushing of the extensor muscles of the foot was disclosed. Periosteum of the upper fragments was denuded for a distance of about three inches. The entire wound was débrided, including the ends of the bone. The fracture was reduced and the reduction maintained by kangaroo tendon sutures placed obliquely through drill holes. No deep sutures. Interrupted chromic catgut for the skin. Circular plaster cast from toes to mid-thigh was then applied. On November 2, the wound was inspected through a window cut in the cast, and found to be clean. Temperature and pulse remained normal, and convalescence was uneventful. The wound healed by primary union.

Now, one year later, there is firm union, no shortening, and no limp. (See Figs. 27 and 28.)

CASE VII.—H. G., age sixteen years. Admitted November 8, 1926, discharged January 6, 1927. This patient was knocked down by a taxicab, and he received an injury to the left leg when one of the wheels passed over it. He was admitted to the New York Hospital soon afterward, and presented the following:

There was a transverse lacerated wound over the front of the leg at the junction of the middle and lower thirds which measured  $1\frac{1}{2}$  inches. The surrounding skin was moderately traumatized. The fractured tibia was visible in the centre of the wound.

At operation, performed one and a half hours after admission, the usual preparation was carried out. A longitudinal incision 8 inches in length was made. A large dissecting hæmatoma was seen along the front of the tibia beneath the periosteum. This extended to within two inches below the knee. There was considerable crushing of the posterior tibial muscles. The wound was thoroughly débrided, the hæmatoma was

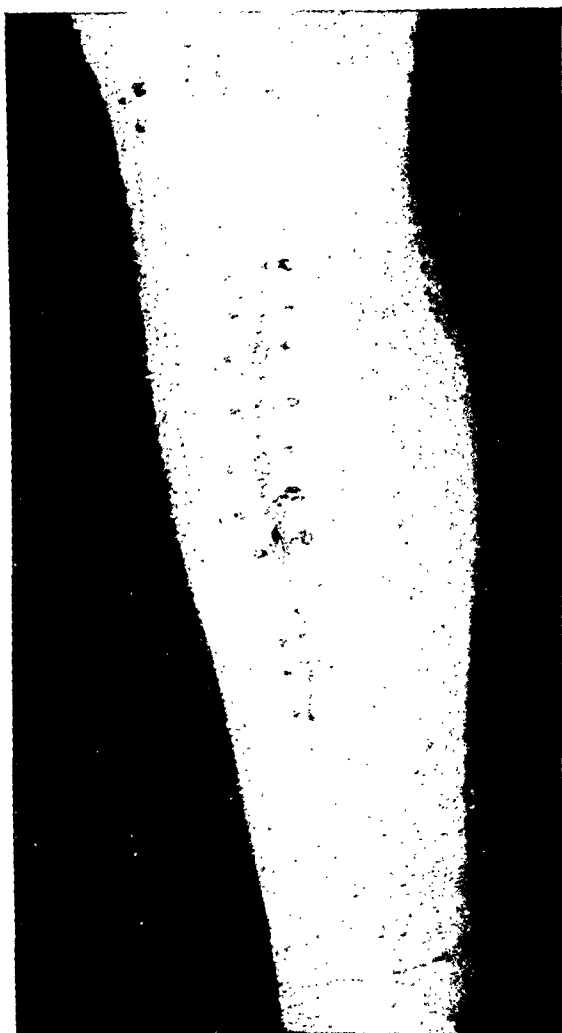


FIG. 27.—Case No. VI described in the text. The photograph was taken eighteen days after the operation.

evacuated, and all traumatized muscle was excised. Fracture was reduced and locked. One kangaroo suture was placed about the tibia at the site of fracture. Interrupted chromic sutures for the skin. No drainage. Releasing incisions were made on each side of the incision because of the apparent trauma to the skin. It was thought that the skin over this region would probably slough. A window was cut in the cast, and the wound was inspected daily. The temperature and pulse remained normal. The skin which had



FIG. 28.—See figure 27.

been traumatized at the time of accident, sloughed, leaving an area 7 x 3 inches. This was dakinized, and on December 20, small, deep grafts were applied. The wound was completely healed two weeks later, and the patient was discharged from the hospital.

Now, one year later, union is firm, the scar does not break down, there is no shortening or limp. (See Figs. 21-26.)

The majority of these wounds can be closed without drainage. If, however, the history of the injury indicates a strong possibility of contamination with anaërobic organisms and there has been considerable soft part trauma, then discretion should be the better part of valor and the wound should be left wide open, to be dakinized by the Carrel-Dakin technic. A secondary

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

suture or skin grafting can be done at a later date. If these facts are taken into consideration, indiscriminate closure of all wounds will be avoided and the incidence of gas gangrene will decline.

CASE VIII.—D. U., age four. Admitted September 12, 1925, discharged January 2, 1926. A half hour before admission to the New York Hospital, this patient was run over by a taxicab, two wheels passing over his left leg. On questioning, it was found that the street where the accident occurred was plentifully covered with manure; in fact, at the time of operation, numerous particles were seen in the wound. Operation, performed immediately, showed a compound fracture of the left tibia and fibula with avulsion of the skin over a distance measuring two square inches. After the usual preparation, a débridement was performed, the fracture was reduced, and the wound was left wide open. Convalescence was uneventful, except for the fact that on two occasions it was necessary to reduce the fragments at the site of fracture. The wound healed by granulation, after thorough dakinization, and was soon covered by a thin layer of epithelium, intimately attached to the bone. After discharge from the hospital, it was noticed that the slightest trauma produced an ulceration in the scar. One year later the patient was readmitted to the hospital, and a pedunculated skin flap, taken from back of other leg, applied after excision of scar. This was done in three stages. Photographs indicate



FIG. 29.—Case No. VIII reported in the text. X-rays indicate the position of the fragments soon after operation with the Dakin tubes in place and the result at the end of twenty months. The photographs show the thin scar at the site of injury and the method used in applying a pedicle skin flap in three stages and the result at the end of sixteen months.



FIG. 30.—See figure 29.

manner in which this was accomplished.

At the present time, two years after the accident, there is no shortening, and there has been no evidence of ulceration at any time in the grafted skin. (See Figs. 29-36.)

Because of the extensive musculature and the consequent greater soft part crushing, compound fractures of the femur should rarely be

closed without drainage. Gas gangrene starting in this region carries a high mortality. We have always left these wounds wide open, followed by dakini-

zation and, often, by secondary suture. In the vast majority of compound fractures, it is rarely necessary to insert deep sutures. The tissues fall together after the fracture is reduced. Again, great emphasis must be placed upon the necessity of obtaining absolute hæmostasis.

External fixation in nearly all uncomplicated fractures of the arm, leg or forearm, can be obtained by the application of a circular plaster cast. A window is immediately cut in the cast, exposing the operative wound. This is inspected daily for the slightest evidence of gas bacillus or other infection. A careful watch is kept of

the temperature and pulse rate. A sudden elevation of both is of serious prognostic significance, indicating usually beginning gas gangrene. In



FIG. 31.—See figure 29.

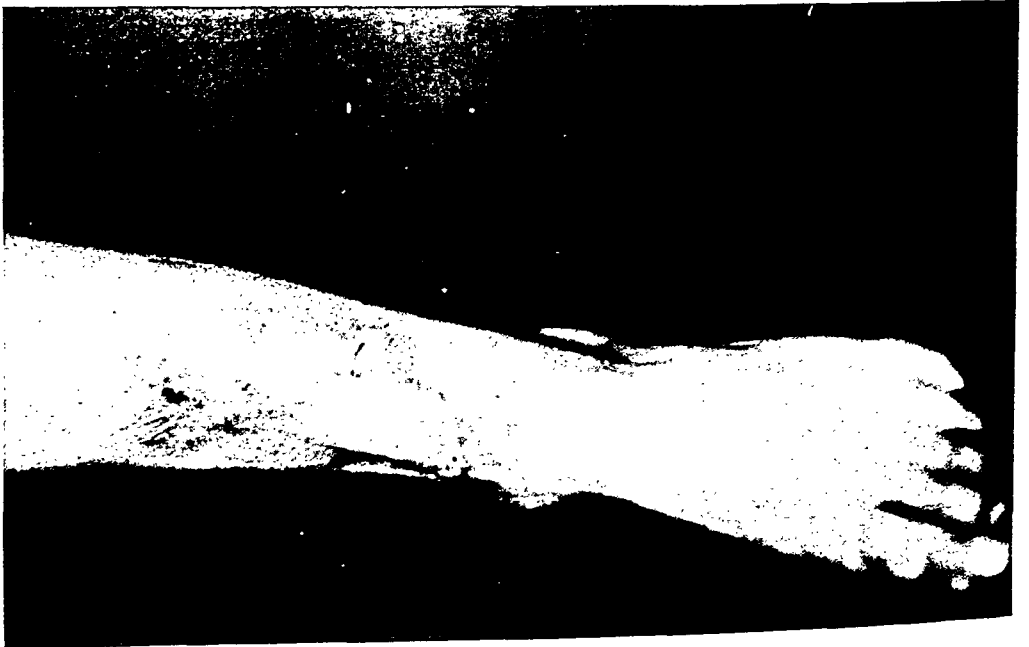


FIG. 32.—See figure 29.

femur injuries and others not sutured, or with loss of considerable skin, traction and suspension is indicated. Dressing of wounds is thereby greatly

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

simplified. The subsequent treatment of these cases is dependent upon the type of injury, and follows the same general rules observed in the treatment of simple fractures.

### WOUNDS WITH LOSS OF SKIN

In our work on this general subject, the problems involved in the treatment of wounds with loss of large skin areas have probably been of greatest

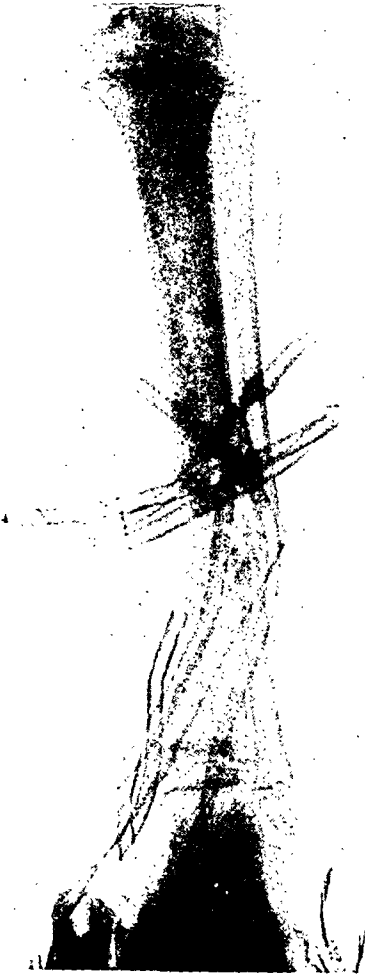


FIG. 33.—See figure 29.



FIG. 34.—See figure 29.

interest. No two cases exhibit similar injuries. Each presents a separate individual problem which must be solved according to the existing conditions. It is for this reason that no hard and fast rules can be made to govern treatment.

In wounds of lesser magnitude, without associated bone or other injury, it is frequently possible to undermine the skin edges, after thorough débridement, and bring about satisfactory apposition. In doing so, it may become necessary to shift adjacent skin areas by a plastic operation, according to the now well-known principles governing such procedures. When, however, after careful study, it is seen that such an operation would jeopardize the vitality of the adjacent skin, other methods present themselves for consideration.



FIG. 35.—See figure 29.



FIG. 36.—See figure 29.



## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

In such wounds of the extremities without associated bone injury, one of four procedures may be utilized, according to the local indications:

I. It may be feasible to perform a débridement and apply immediately a

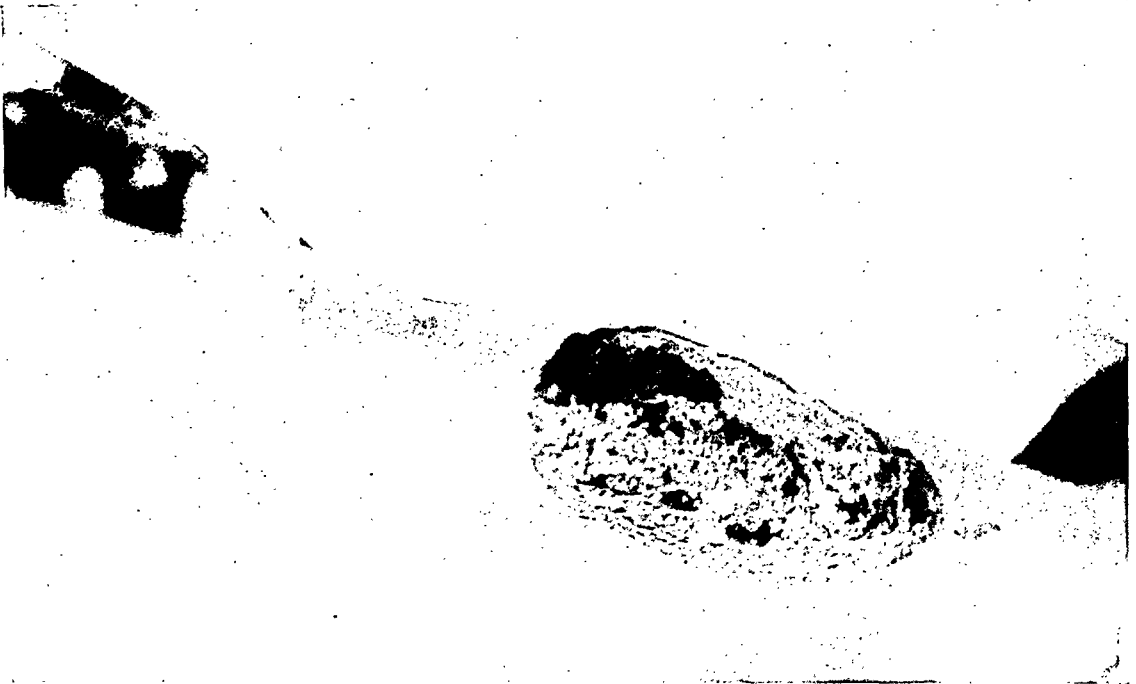


FIG. 37.—Case No. X described in the text, indicating the appearance of the wound five days after operation.

pedunculated flap from an adjacent or distant region of the body. This method would seem to apply particularly to wounds of the hand and wrist.

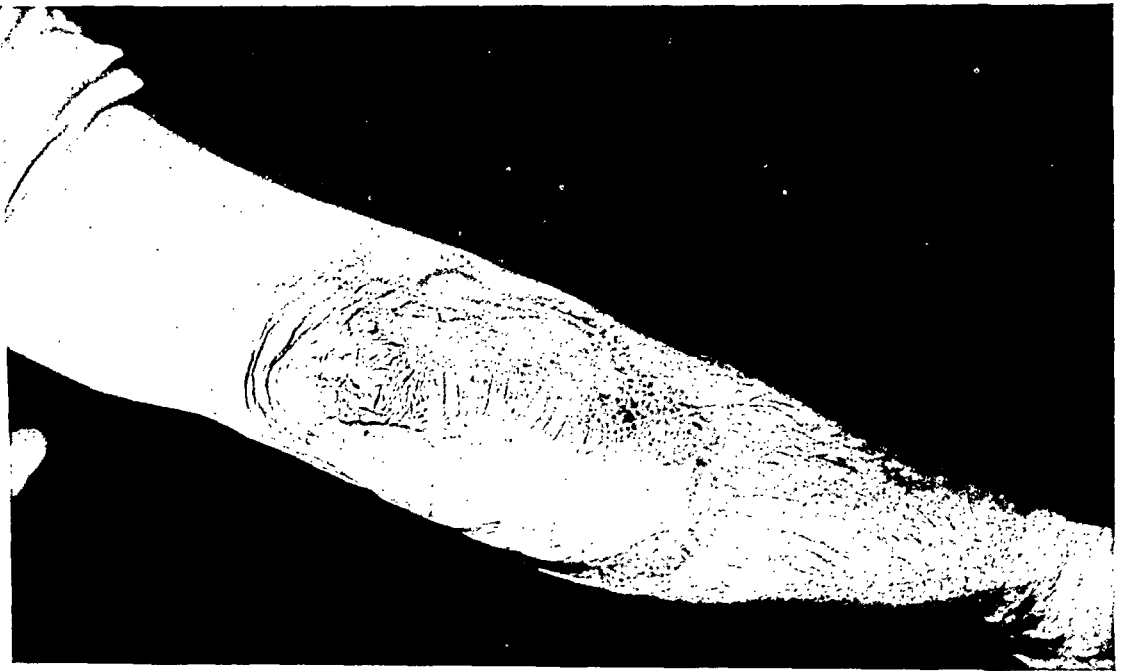


FIG. 38.—Case No. X, one and one-half years later.

Inserting the hand beneath a skin flap on the abdomen at the primary operation is a proper and justifiable procedure, providing there are no contraindications locally in the type and extent of the hand wound.

CASE IX.—D. C., age twenty-four years. Admitted March 16, 1925, discharged June 1, 1925. Patient injured his right hand just before admission, when it became caught in a macaroni rolling machine.

Operation was performed forty-five minutes after admission. It was seen that all the skin and subcutaneous tissues from the wrist to the middle phalanges of all the

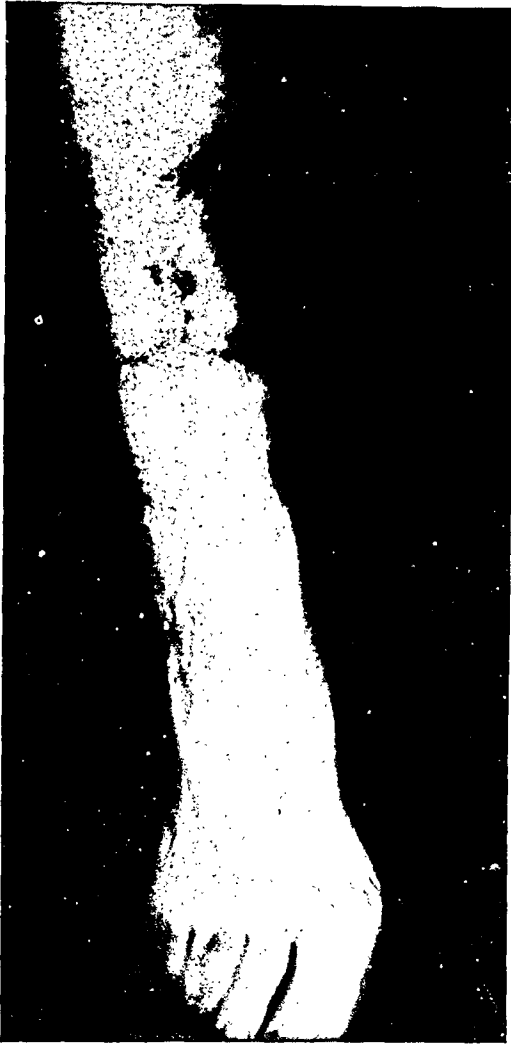


FIG. 39.—Case No. XI described in the text. The X-rays indicate the fracture a few days after operation, and show the method described in the text, of applying a plaster boot and a cast above the fracture, incorporating in both, the ends of curved metal rods, thereby immobilizing the fracture, and allowing easy access to the wound. The other X-rays and photographs indicate the result at the end of two years.

fingers had been turned inside out as though it were a glove. There was considerable trauma to these tissues. The little finger was practically completely amputated. Operation consisted in the usual preparation followed by a complete débridement. The flap was turned back and sutured to the skin at the wrist with two silkworm gut sutures. Incisions were made in the web spaces and the whole hand was extensively drained. X-rays later disclosed fractures of the first, second, and third metacarpal bones, and the proximal phalanges of the index and middle fingers. As was expected, the skin sloughed, as indicated in the photographs. After the wounds had been treated by the Carrel-Dakin technic, it was decided to apply a pedunculated skin flap from the abdomen. On April 14, the first stage was done. The hand was placed beneath a skin flap broad enough to cover the wound on the dorsum of the hand. A plaster cast was applied immobilizing the arm to the side. On April 30, the upper attachment of the flap was divided. Circulation was good. The lower pedicle was extended further, the purpose of this being to roll the hand in such a way so that the flap would unite to the wound on the front of the hand in one continuous piece. The pedicle was further extended two inches and the hand was rolled upward. On May 6, the third stage was performed, when again the lower pedicle was extended for  $1\frac{1}{2}$  inches. At the fourth stage, the lower pedicle was divided and the abdominal wound closed by a plastic undermining of the skin. The flap was then rolled around the front of the hand so as to cover the deficiency of the palm. One suture used.

On May 26, the flap was revised and made to conform to the shape of the wound in the palm of the hand. Excess fat was excised at this operation. These various stages are indicated in the accompanying photographs. (See Figs. 44-53.)

While the patient was being treated in the dispensary, it was noticed that there was marked limitation of flexion in the metacarpo-phalangeal joints of the middle and ring fingers. The flap on the dorsum of the hand appeared too thick. The patient was therefore readmitted September 16, 1925, and an operation was performed. This consisted of excision of the scar in the region of the metacarpo-phalangeal joints, freeing of the extensor tendons, and posterior capsulotomy of the metacarpo-phalangeal joints of the

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

ring and middle fingers. The excess fat in the graft along the inner side of the hand was excised. The fingers were put up in acute flexion. The patient was discharged September 21, with the wound healed, showing a marked improvement in flexion of the ring and middle fingers. To reduce the thickness of the flap on the outer side of the hand, another operation was performed on January 21, 1926. On this date, excess fat and skin was excised.

At the present time, two and a half years following the accident, there is practically normal motion in all of the fingers, the hand, cosmetically, is quite presentable; and the skin has acquired sensation. The patient has returned to his former occupation.

II. For the majority of wounds, probably the most logical procedure is a thorough débridement followed immediately by the application of Thiersch grafts, as was recently suggested by H. H. M. Lyle. By this operation, one hastens convalescence, and, most important of all, diminishes to an astonishing extent, the degree of fibrosis in the subcutaneous tissues which always follows the slower process of healing by granulation and epithelialization from the sides. At a later date, if thicker skin is necessary, a pedunculated flap can be applied at one's leisure. We have often been impressed by the value of this method.

III. If the wound is accompanied by extensive crushing and devitalization of tissue, it is probably wiser not to attempt immediate skin grafting, contenting oneself with as thorough a débridement as possible. Intensive dakinization subsequently, followed by the application of Thiersch or small, deep grafts as soon as the appearance and bacteriology of the wound permits, forms the basis of the additional treatment.

CASE X.—F. B., age fifty. Admitted March 22, 1926, discharged April 23, 1926. An hour before admission, the patient caught his right arm in the gears of a washing machine. The skin over the posterior aspect over the elbow, forearm, and arm was avulsed.

At operation, it was seen that the skin and subcutaneous tissues over an area measuring  $9 \times 3\frac{1}{2}$  inches had been avulsed. The tip of the olecranon process of the ulna was fractured and the elbow-joint was visible. There was no nerve injury. A large amount of dirt and grease had been ground into the wound. Operation consisted of the usual preparation followed by thorough débridement. The arm was put up in extension in a Thomas splint and dakinized. On April 14, 1926, the area was covered with half thickness skin grafts taken from the front of the thigh. The elbow was put up in acute flexion. Convalescence was uneventful.



FIG. 40.—See figure 39.

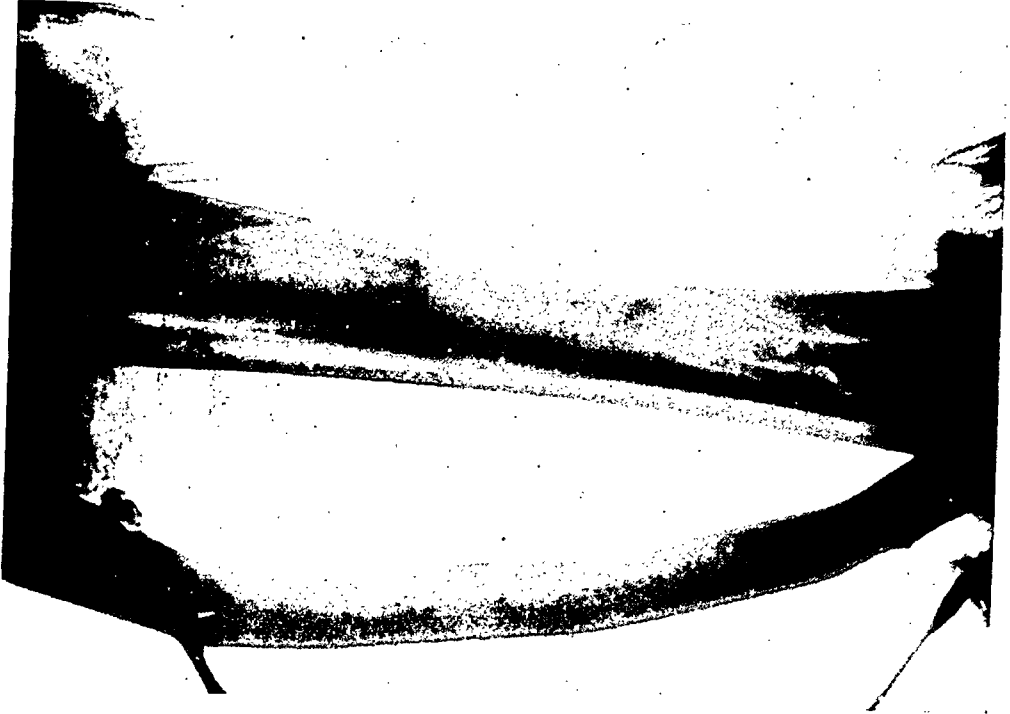


FIG. 42.—See figure 39.

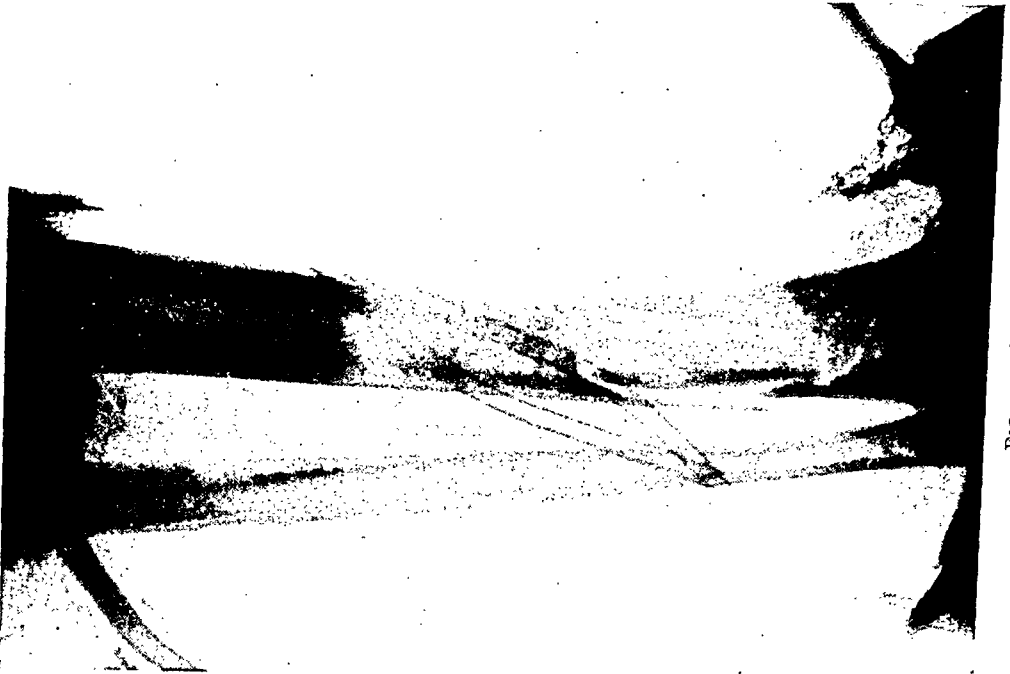


FIG. 41.—See figure 39.

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

Now, one and a half years later, the wound is completely healed, and there is normal motion in the elbow-joint. The patient has returned to his former occupation. (See Figs. 37 and 38.)

IV. It may occasionally be possible to apply a free, full-thickness skin graft, according to the technic worked out by Blair, Davis, McWilliams and others, after thorough débridement. Our experience in this form of skin grafting for traumatic wounds has been very limited. Theoretically, it is a method open to many objections for the particular type of case under consideration and carries with it too much risk as to the viability of the graft, to warrant its recommendation.

When, in addition to loss of skin, there is an associated bone injury, it is doubtful whether any form of skin grafting should be attempted at the primary operation. In the majority of these cases, the bone lies exposed in the wound and grafts placed over such soil will not take. Therefore, a thorough débridement with reduction of the fracture, should constitute the extent of the primary procedure. The wound is dakinized subsequently and, when the area has become filled in with granulations, skin



FIG. 43.—See figure 39.

grafts are applied. In fractures of the tibia under such conditions, an excellent method of simplifying dressings consists in placing a plaster boot on the foot and ankle and a plaster cast about the leg, knee and thigh, leaving the injured area uncovered for the entire circumference. Strong curved metal rods are incorporated in the boot and the cast above, thereby at the same time immobilizing the fracture and allowing easy access to the wound.

CASE XI.—P. McA., age fifty-one. Admitted July 22, 1925, discharged October 19, 1925. While getting off a tug, this patient caught his right leg between the bow of the tug and a post on the dock, receiving a crushing injury. He was admitted to the New York Hospital in considerable shock, which was combated by an intravenous injection of glucose and insulin. At operation, there was found a two-inch transverse lacerated



FIG. 45.—See figure 44.

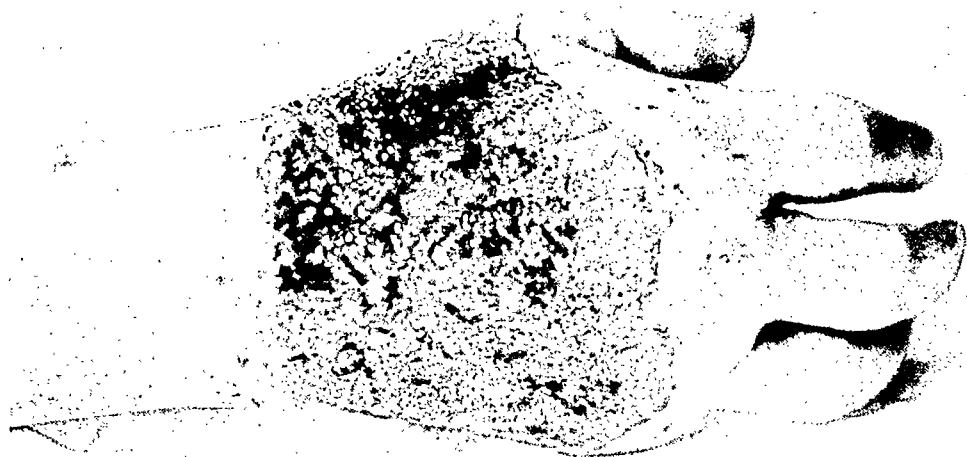


FIG. 44.—Case No. IX described in the text. The photographs indicate the appearance of the hand on the sixteenth day following the injury and the method used in covering the wound with a pedunculated skin flap from the abdomen. Unfortunately, photographs were not taken after the final stage. At the present time, the flap is much thinner than the photographs indicate, and there is normal motion in the finger joints.

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

wound along the inner side of the right leg at the junction of the middle and lower thirds, with two similar wounds anteriorly, and one on the outer side. The skin for a distance of six inches around this area was obviously dead. After exposure, it was found that all the muscles and subcutaneous tissues along the inner and posterior aspects were severely crushed. The posterior tibial vessels were found divided. The nerves were intact. The tibia was fractured in a comminuted manner with long anterior and posterior fragments. The anterior tibial vessels appeared to be intact. After the usual preparation, the entire area was débrided, including the traumatized skin. This left a gap, measuring 12 x 7 cm. A strand of kangaroo tendon was placed around the fracture. The wound was left wide open and a plaster boot applied with a circular plaster cast about the upper leg, knee and thigh, incorporating the curved metal rods in the plaster, as described in the text. The convalescence was uneventful. The wound was dakinized and the circulation of the foot remained good. Five weeks after operation, it was found that union was firm, but that there was a granulating area along the inner and posterior aspect of the leg, measuring  $6\frac{1}{2} \times 12$  cm. This area was subsequently covered by a pedunculated skin flap taken from the back of the opposite leg. This procedure was accomplished in three stages. The accompanying photographs indicate the end-result at the end of two years. (See Figs. 39-43.)



FIG. 46.—See figure 44.

The type of skin

transplantation which is

done later must be carefully considered. Fractures of the tibia with loss of skin should always be covered with a pedicled skin flap. Such wounds when covered with Thiersch or Davis grafts ulcerate on the slightest trauma, when weight bearing is reestablished. With thicker skin flaps, such is not the case. In other situations where the bone does not lie subcutaneously, Thiersch or small, deep grafts suffice, as a rule.



FIG. 48.—See figure 44.



FIG. 47.—See figure 44.



## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

### AMPUTATIONS

It is not within the scope of this paper to go into a detailed study of the subject of amputations. It is desired only to emphasize certain general principles pertaining to the subject of amputations for traumatic lesions.

In general, every attempt should be made to preserve a limb, providing this can be done with a clear understanding of the possibilities involved. Some will subsequently come to secondary amputation, but the not infrequent case will come through with a serviceable limb. It is doubtful whether the adoption of this policy has resulted in an increased mortality. At least, a study of our cases does not indicate this.

Because of the local conditions present, primary amputations often become necessary:

I. When the entire blood supply distal to the injury has been cut off by the trauma, amputation is indicated. The absence of palpable pulses, the color of the extremity and the surface temperature variations, as compared with the sound side, will guide the surgeon in determining his course.

II. Not infrequently one encounters a case where there has been an avulsion of the skin and subcutaneous tissues of an entire leg or forearm. Such an injury is usually accompanied by crushing of the muscles and occasionally by fractures. It is very doubtful whether any attempt should be made to preserve such a limb. The extent and severity of the trauma will be the guiding factors.

III. Irreparable crushing of bone, always accompanied by crushing of soft parts, calls for amputation. The injuries produced by heavy vehicles constitute the bulk of the cases making up this group.



FIG. 49.—See figure 44.



FIG. 51.—See figure 44.



FIG. 50.—See figure 44.

## TREATMENT OF COMPOUND INJURIES OF EXTREMITIES

The site of amputation will depend on the situation and extent of the injury, the proximity of neighboring joints and a consideration of the subsequent use of an artificial limb. In general, it may be said that amputation should be performed in such a way as to leave a most serviceable stump, whether this be for an artificial limb, a prosthesis or for cosmetic reasons. It would, therefore, be inadvisable to amputate a leg, for instance, just below the knee-joint. A lower thigh amputation would be more serviceable to the patient from the standpoint of an artificial limb. In some varieties of amputations, every attempt should be

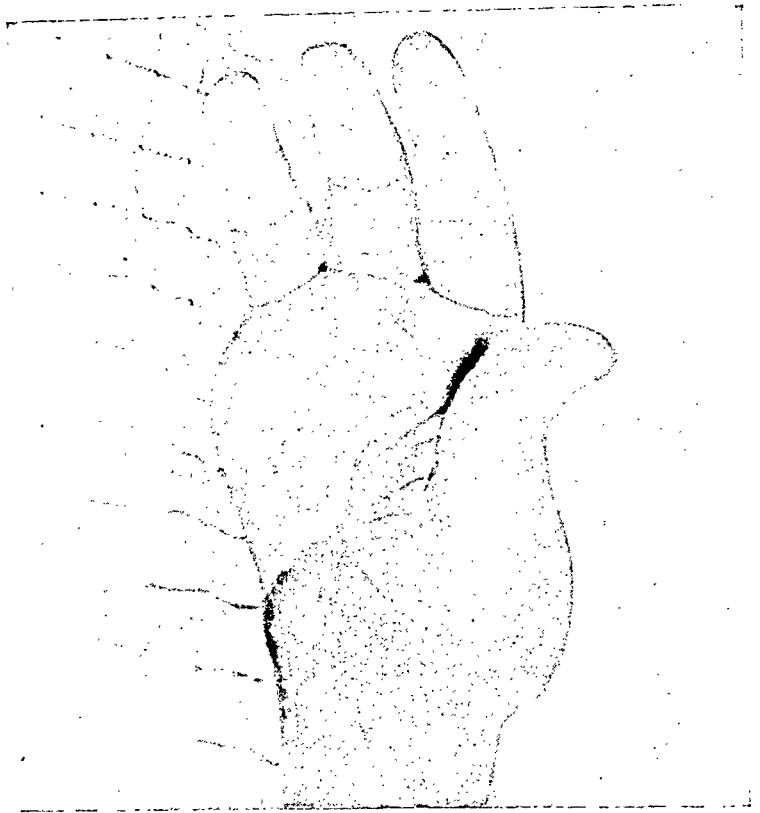


FIG. 52.—See figure 44.

made to preserve as much tissue as possible. This applies particularly to upper extremity injuries, especially the hand. Unless hopelessly crushed, every effort should be made to preserve part of the hand. If the thumb

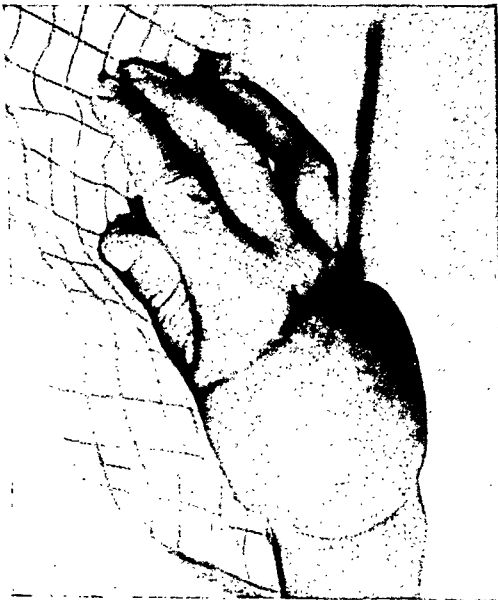


FIG. 53.—See figure 44.

alone can be saved, a great deal will be accomplished. With an intact thumb, it is surprising what can be done, in the line of reconstruction work, later, with the remains of the other digits.

As to the technic of amputation, only one or two general principles need be emphasized. It seems wholly immaterial what type of flaps is fashioned, provided sufficient tissue is left to make a well-padded stump. It is essential to divide the bone considerably higher up than the soft part amputation and to section all nerves at some distance above the end of the stump to prevent later stump neuromata. The most important

question to be decided pertains to the advisability of suturing such amputation wounds at operation. Although amputation is performed through normal and

relatively clean tissue, the close proximity of the wound with its tissue trauma and implantation of bacteria makes immediate closure a step demanding serious consideration. It must be remembered that, as most of these injuries are caused by motor vehicles on public thoroughfares, the likelihood of a general contamination with anaërobic bacteria must be greatly increased. Undoubtedly, a number will heal without difficulty after primary suture. But, a few unfortunate experiences, involving the development of gas bacillus infection in the sutured stump requiring reamputation, in spite of careful skin preparation, have convinced the writer that, as a general rule, it is much safer to leave the wound wide open, after fashioning long flaps, sectioning the bone and nerves high up and carefully ligating all bleeding points. When it is evident, at a later date, that there is no infection, the application of a few sterile adhesive straps, carefully coapting the skin edges of the flaps, will bring about rapid and satisfactory healing. It is by adopting this safe procedure that it will be possible to decrease the incidence of the greatest and most serious complication of compound injuries of the extremities, namely, gas gangrene.

## HEAD INJURIES IN CHILDREN\*

AN ANALYSIS OF 331 CASES WITH ESPECIAL REFERENCE TO END RESULTS

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THIS paper is a report of a study of 331 cases of injuries to the head in children under thirteen years of age, admitted to the Children's Surgical Service of Bellevue Hospital during the years 1921 to 1926 inclusive.

Though the condition of the patients, on admission and during their hospital stay, has been studied, an additional analysis has been made of those cases which were followed through the Return Clinic, in an attempt to find out the end results of their injuries.

As the seriousness of any head injury depends in direct relation to the amount of damage produced to the cranial contents and not to the extent of the fracture of the skull, it has seemed wise to include in this analysis all cases which showed any signs of intra-cranial injury. Therefore of the 331 cases reported there were 214 discharged with the diagnosis of fracture of the skull and 117 with a diagnosis of intra-cranial injury without fracture of the skull. A diagnosis of fracture of the skull was made in those cases showing the classical clinical symptoms of the condition or where an X-ray examination demonstrated a loss of continuity in the bones of the skull. There is a probability that some of those cases placed in the group of intra-cranial injury without fracture of the skull, in reality had a fracture without producing clinical symptoms or being demonstrated by the X-ray.

Of the 331 patients admitted to the hospital, thirty-eight died, all in the fractured skull group. Of those cases that lived to be discharged from the hospital, 234 were followed up through the Return Clinic, for periods varying from two months to five years; 151 of these cases were of the fractured skull group and eighty-three were in the group of intra-cranial injury without fracture of the skull. All of the cases returning were seen by members of the staff of the Children's Surgical Service, some were sent for special examination to the Departments of Neurology or Psychiatry, and at times the teachers of these children were questioned as to the child's condition before and after the injury.

In the results reported, any patient complaining of symptoms, referable to their injury, at any visit to the Return Clinic, were placed amongst those showing sequelæ, even though they may have been seen only six weeks or two months after they had left the hospital.

The ages of the children varied from under one year to thirteen years of age. There was little difference between the number of cases at different ages,

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\* Presented before the Section of Neurology and Psychiatry, New York Academy of Medicine, December 13, 1927.

after the third year of life. Seventy-eight per cent. of the patients were boys. In 123 cases the injury was the result of a collision with a vehicle, usually an automobile; in eighty-six the result of a high fall (a distance of ten feet or more); in thirty-three a short fall produced the injury; twelve were struck on the head by some object and in seventy-five of the cases the histories did not state what caused the injury. However, the prognosis of the seriousness of the condition can not be made from the type of accident producing it, as shown in the case of two children, of three and five years, respectively, who fell from fifth story windows, in whom there were no apparent injuries when admitted to the hospital, while a boy, of seven years of age, falling from the second step on to the sidewalk was for many days unconscious, suffering from an injury to the brain, the result of a fracture of the middle fossa of the skull.

In classifying these cases, those patients showing a period of unconsciousness, shortly followed by a stage of reaction, in which they vomited, and where there were none of the local clinical signs of fractured skull, together with a report of a negative X-ray examination, were placed in the group of intra-cranial injuries without fracture of the skull.

In the fracture of the skull group of cases, the diagnosis was established by seeing or palpating the fracture as in the case of depressed or compound fractures; by the local clinical signs the result of injury to blood-vessels, cranial nerves or to the covering of the brain; or by positive findings on X-ray examination.

To attempt to make an accurate classification of the location of the fracture is impossible in a group of clinical cases. Fractures of the base usually extend into the vault and likewise those of the vault frequently run to the base. Examination at necropsy is the only accurate means of obtaining the knowledge sought. However, from data obtained from 175 histories concerning the clinical symptoms presented, together with the X-ray findings, the following classification was compiled in an attempt to place the location of the fractures for this series:

	Per cent.
Anterior fossa .....	21
Anterior and middle fossa .....	8
Middle fossa .....	25
Middle and posterior fossa .....	7
Posterior fossa .....	12
All three fossæ .....	1
Vault .....	26 (Depressed 7%)

The diagnosis of fracture of the skull was frequently made only by means of the X-ray. Thus in 123 cases in which the reports of the X-ray examination were positive, fifty-seven showed none of the classical symptoms of fracture of the skull, though thirty-six did have hæmatomas beneath the scalp over the site of the fracture. In six of the histories of the remaining twenty-one cases it was definitely stated that the individual had not had a period of unconsciousness following injury. Thus, in these six cases, the

## HEAD INJURIES IN CHILDREN

diagnosis of fracture of the skull was made entirely on the history of injury, and a positive finding on X-ray examination.

In 21 per cent. of these cases of fracture of the skull, in which there was a record upon the chart of a röntgenogram examination, the report was negative for fracture, though the clinical symptoms were present. Undoubtedly in most, if not all, of these cases a positive report for the examination could have been obtained, if enough exposures had been secured through sufficient plains of the skull.

In the histories of forty-eight of the fractures of the skull group, there were no X-ray reports. However, thirty of these patients died and were probably too sick to be moved for the examination.

If for the sake of discussion, these 214 cases of fracture of the skull be divided into groups, according to the severity of their symptoms, as shown at the time of admission to the hospital; that is, those showing little, if any, signs of cerebral injury being classified as mild, those showing a period of unconsciousness lasting only a few hours and soon reacting as moderate, and those in deep coma, irritable or having general convulsions being classified as grave; there would be forty in the mild, ninety-eight in the moderate and seventy-six in the grave groups. Most of the cases in the mild group were those with fractures of the vault, both fissured and depressed, while practically all those classified as grave gave clinical signs of extensive fractures of the base, by far the greater number involving the middle fossa of the skull.

The extent of the fracture line in the vault, in cases of linear fracture, did not necessarily bear a direct relation to the severity of the cerebral injury as shown by the following cases:

CASE I.—A girl, nine years of age, was admitted on May 15, 1923, having been knocked down by an automobile and striking her head against the curbing. There was a slight abrasion over the right temporal region. She was conscious and orientated. There was a small hæmatoma over the right parietal region, otherwise nothing was found on examination.

The report from the X-ray was: "That there is a fracture extending completely around the skull. The line of fracture beginning at the right side of the frontal bone goes backward to the parietal and extends around to the left side. There is evidence of increased intra-cranial pressure." This child was last seen in the Return Clinic in March, 1926, three years after the accident, having never suffered from any symptoms referable to it.

CASE II.—A boy, seven years of age, was admitted to the hospital on May 23, 1924, having fallen from a fire-escape just prior to admission. He was unconscious when picked up. He vomited once. On examination he was found to be slightly drowsy but could answer questions. There was a small swelling in the left parietal region of the skull, which was soft and tender. There were no other symptoms found.

The X-ray department reported: "Comminuted fracture of the skull; one line of the fracture running from the middle fossa backward along the parietal bone bifurcating in the occipital region; one line running upward into the parietal and the other running downward and around the occipital to the right side. Marked increased intra-cranial pressure."

This boy was followed for one and a half years and never showed any symptoms resulting from the accident.

CASE III.—A girl, five years of age, just before admission, had fallen from a fire-escape, a distance of four stories, on to a patch of earth. There was no loss of consciousness. It was thought she struck a clothes line in the fall. She vomited several times.

Examination showed a large swelling of the forehead more marked on the right side. This apparently was a hæmatoma. Later she developed ecchymosis under both eyelids. The X-ray department reported: "A fracture of the fronto-parietal bones, the line of fracture running transversely beginning on the right side and extending completely around to the left." On careful examination it was found that the skull cap could be felt to shift laterally, therefore there was apparently a complete fracture around the circumference of the calvarium.

This child was followed in the Return Clinic for two years without ever having any complaints referable to her accident.

The fact that in childhood the dura is not attached firmly to the inner surface of the bones of the vault, no doubt, explains the possibility of having extensive fractures of the vault without producing cerebral damage, while at the base where the dura is firmly attached, any fracture line lacerates the membrane.

There were twenty-seven patients with depressed fractures of the skull. Fourteen of these were compound fractures. In the thirteen patients with simple depressions there were few, if any, other symptoms due to the fractured skull or injury to the brain; in five the history noted that they had not been unconscious; one showed signs of an extension of the fracture line into the anterior fossa and in another apparently the middle fossa was also involved as there was some weakness of the side of the face. Two with depressions in the parietal region showed some weakness in the upper limb on the opposite side, but this soon disappeared. None of the patients with simple depressions were operated upon.

Of the fourteen cases with compound depressed fractures all were operated upon except one, a patient with a fracture in the frontal region, in which case the child was not admitted until twenty-four hours after the accident, and the wound was infected. Though the dura was open and brain tissue was presenting in the wound, the patient recovered, but now has a defect in his skull and has suffered with frequent headaches for three years. This case is the only one among the twenty-three with depressed fractures in which there is a complaint of a sequela.

The cerebral symptoms shown by the patients with compound depressed fractures were more commonly seen and were more severe than those with the simple depressed fractures. In five of these cases the dura had not been opened, two of these had no cerebral symptoms; the other three showed signs of compression. In the remaining nine cases the dura had been lacerated. Three of these showed no signs of brain injury; two had definite convulsions, and the remaining four patients were delirious and irritable, the result of definite laceration to the brain. There were four deaths, all in cases with signs of marked laceration of the brain substance. In three of the cases there are now bony defects in the skull due to the failure of the



## HEAD INJURIES IN CHILDREN

operator to replace fragments removed at the time of operation; this causes discomfiture to the patient.

There was no case of extradural hemorrhage from the meningeal arteries in the entire series. Vance (*Archives of Surgery*, May, 1927, vol. xiv, pp. 1023) explains the infrequency of this condition in the young by the shallowness of the bony grooves for the meningeal vessels, and the slight attachment of the dura to the bones of the vault. There was, however, one patient, a boy of nine, who showed signs of a progressive increasing compression of the brain. He had a large tense hæmatoma of the scalp in the right parietal region. Incision into this hæmatoma evacuated blood under pressure. The hæmatoma communicated with the extradural space through a long fissured fracture. On further investigation the dura showed signs of having been compressed. The location of the origin of the hemorrhage could not be found. The patient recovered.

Seventy-four per cent. of the injuries to the skull were apparently fractures involving the base of the skull. Most of these cases fall into the moderately severe and grave groups. Of seventy-four cases of fracture of the base of the skull, where the X-ray demonstrated an actual fracture of that portion of the skull, in eight of the patients, there were no clinical signs of such fracture, and in three of these there were no signs of cerebral injury.

Seventy-four per cent. of the sequelæ reported from the Return Clinic were found in patients who had had a fracture of the base. This hardly needs an explanation.

There were thirty-eight deaths listed. This is not an accurate statement, as many cases were dead on arrival in the wards and these have not been included in this series. Seven cases died from meningitis, in all of these there was a fracture of the anterior fossa. Of the remaining thirty-one cases, twenty-eight died in the first forty-eight hours. All of these latter patients showed signs of severe laceration to the brain. In the three remaining cases who died over forty-eight hours and within five days after admission, death was apparently due to compression the result of œdema. One death was reported from the Return Clinic, of a boy who had a fracture of the middle fossa, and had been discharged apparently cured. He died in another hospital two years after the accident from an abscess of the brain.

Of 234 cases followed in the Return Clinic, 151 were of the fractured skull group and eighty-three of the intra-cranial injury group without a fracture of the skull. Forty-eight, or about 33.3 per cent. of the fracture of the skull group, had definite complaints of sequelæ, while only 6, or about 7 per cent. of the intra-cranial injury group, had such complaints. Thus about 23 per cent. of the followed cases of head injuries had some type of symptom following their accident. In most cases, these symptoms disappeared after a short period of time. Thus thirty-seven, 70 per cent., of these patients, in from one to two years, ceased to have such complaints. Of the

seventeen cases, with a continuous unsatisfactory Return Clinic record, seven showed no improvement over the period in which they were followed, six showed improvement, and in four, who were lost, the period during which they were followed was not long enough to form a definite opinion as to the final state of their health. So in eleven cases, or about 5 per cent. of those followed up, there was a possibility of permanent damage. None of the sequelæ, of the intra-cranial injury without a fracture of the skull group, continued longer than a year.

Only five of the cases with late complaints had fractures of the vault alone, but in all of these the fracture was extensive, and there was a definite injury to the brain. In twenty-nine of the cases with sequelæ in the fracture skull group, the fracture line passed through the middle fossa and frequently two or more of the fossæ appeared to be involved. The majority of the cases with sequelæ were classified as grave, from their original symptoms.

The symptoms of the fracture of the skull and of the brain injury were similar to those seen in the adult. Hæmatomas of the scalp appeared to be more commonly found overlying fractures of the vault. Bleeding from the orifices, nose and ear, were usually found in fractures of the anterior and middle fossæ, respectively. In only six cases out of sixty-six fractures classified as involving the middle fossa was there found cerebrospinal fluid discharging from the ear. But in approximately one-fourth of the fractures of the middle fossa, the diagnosis could only be made by X-ray examination as no typical clinical signs were present, though later submastoid ecchymosis occasionally developed. Subconjunctival hemorrhage was always observed in fractures of the orbital plate. Well-marked hæmatomas rather than suboccipital ecchymosis appeared frequently in fractures of the posterior fossa.

Symptoms due to injury of cranial nerves were seen in twelve cases; in nine the facial was involved alone; in one the facial and abducens; in one the abducens and in one the facial and auditory nerves were affected. In all but three of these cases there was complete recovery, one of an abducens nerve paralysis, one of injury to the auditory nerve and one of facial nerve paralysis. The facial nerve paralyses usually disappeared rapidly, however, in two of the patients weakness of that side of the face continued for a year.

Infection of the middle ear followed fracture of the middle fossa in two cases. This resulted in an impairment of hearing until the condition was cured.

The symptoms referable to brain injury were similar to those seen in the adult. They varied from those caused by a simple concussion to those, the result of severe laceration of the brain. Symptoms of compression by subdural hemorrhage were fairly common, but as already stated, no case with the typical symptomatology of an extradural hemorrhage was observed.

In most of those cases that recovered, improvement in their condition was seen before the end of forty-eight hours. In fourteen cases there were symptoms of meningeal irritation, without further signs of infection. All of these patients recovered. In two cases, one with a weakness of both right

## HEAD INJURIES IN CHILDREN

extremities, and the other with weakness of the left upper extremity, following apparent subdural hemorrhages, normal function of the parts were not regained until eighteen months in the first and two years in the latter case. There were, however, five other similar cases in which the condition cleared up before the children were discharged from the hospital.

The commonest symptom complained of by patients followed in the Return Clinic was headache. This was noted in twenty-five cases. In three patients it was accompanied by emotional changes as shown by the child's behavior. In four of the children the attacks of headache were accompanied by vomiting. Only one of these patients showed an objective symptom, a paralysis of the facial nerve. The description of the type of headache was quite constant, when noted. Coming on in attacks usually when the child was tired, and located in the frontal region. In all but one case the attacks gradually became less frequent and finally disappeared in periods varying from a few months to two years following the accident. The patient who continued to have headaches was the one in which there had been a depressed compound fracture which was not operated upon. The severity of the original injury did not appear to have any relation to the severity or duration of the headache. In five cases it followed simple concussion without a fracture; in fourteen the base of the skull was fractured resulting in more or less injury to brain substance. Four of these cases were classified as grave, four as moderate and six as mild. In the six remaining cases, the injury was a fracture of the vault, in only one of which was the cerebral damage grave.

Attacks of vertigo were reported by two of our patients. These patients showed no other signs following injury or later of semicircular canal disease, however, the fractures in both of these children involved the middle fossa. The attacks disappeared completely in eighteen months' time.

In nineteen cases the mother complained that the child's behavior had changed since the injury. In many of these, this fact was confirmed by the children's teachers. The severity of this change in behavior varied from mild emotional symptoms—"nervousness", attacks of crying for no apparent cause or slight irritability—to a change in character, where the child became sullen, quarrelsome and incorrigible. In two of the cases, the patients, boys, had to finally be committed to public institutions. In the examination of the more severe types, the children were sullen and non-communicable and were frequently caught in mis-statements. In most of these cases there had been definite injury to brain tissue. In all but three the base of the skull had been fractured. In two cases the original injury had been classified as mild, nine as moderate and eight as grave. Ten children recovered entirely, six were much improved, but in three no change was noted. Two of the latter children had had extensive cerebral injury, and subtemporal decompressions had been performed upon them.

Improvement was rapid in the milder forms when there was coöperation

on the part of the parents. Care, isolation from emotional excitement and training quickly showed their effects on these children's behavior.

In the hospital care of these patients, in this series, operative procedures were seldom used except in cases in which there was a definite indication. In the earlier years, four cases of severe injury to the brain, accompanied by fractures of the base, were decompressed by subtemporal craniotomy. Two of these patients died and the two others showed later poor results.

#### SUMMARY

As in other injuries children stand severe cranial injuries better than adults.

The fact that the dura is not strongly attached to the bones of the vault and that the vessels of the dura lie in comparatively shallow grooves on the inner surface of the skull, prevents frequently laceration of the dura and brain in fractures of the vault.

Fractures of the vault may be often overlooked, as in many cases there are few, if any, symptoms, though hæmatomas of the scalp frequently overlies the fracture line.

The extent of a fracture line of the vault is of no prognostic value to the severity of the cerebral injury.

A simple depressed fracture of the skull is not in itself an indication for operative interference.

Compound depressed fractures are more serious than simple depressed fractures; not only because of the danger of infection that may follow, but because they more frequently produce lacerations to the dura and brain.

In operating for compound depressed fracture, bone fragments should be replaced, if possible, so as not to leave a deficiency in the skull.

Fractures of the base of the skull in children may be overlooked for the lack of clinical symptoms.

Injury to the brain is more commonly found accompanying fracture of the base than fracture of the vault. This is especially the case of fractures of the middle fossa.

Symptoms resulting from brain injury clear up rapidly after the first forty-eight hours, in the cases that recover; in those that die, death usually takes place in the first two days.

Symptoms of meningeal irritation without actual meningeal infection are often seen. Meningitis follows fractures of the anterior fossa more frequently than of any other part of the skull.

About 23 per cent. of children suffering from head injuries have some type of sequelæ, but few of them are permanent. Those having symptoms due to permanent injuries are less than 5 per cent.

As a rule it can be stated that sequelæ are present in direct relation to the severity of the damage produced by the injury.

Fractures of the vault have a lower morbidity than those of the base, especially those of the middle fossa.

## HEAD INJURIES IN CHILDREN

The symptoms complained of in the sequelæ are more often of a subjective or emotional type than those of an objective type.

Headache is the commonest complaint and it usually clears up within a year after the accident.

Emotional instability is seen frequently. This varies anywhere from mild nervousness to a behaviorism which is a total change from the child's former character. These latter symptoms are found most frequently in those children who suffered from a serious injury to the brain.

Conservative treatment gives the best results in head injuries in children.

Operative procedures undertaken without definite indication are to be condemned.

# THE USE OF VISOR FLAPS FROM THE CHEST IN PLASTIC OPERATIONS UPON THE NECK, CHIN AND LIP<sup>1</sup>

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OCCASIONALLY it is necessary to replace the skin upon the anterior surface of the neck and chin, usually in the correction of deformities due to burns, but sometimes for other reasons such as an injury or an extensive hæmangioma.

In these burns, although the face often is more or less involved, the chest may be spared, if protected by the clothing. This protection may even



FIG. 1.

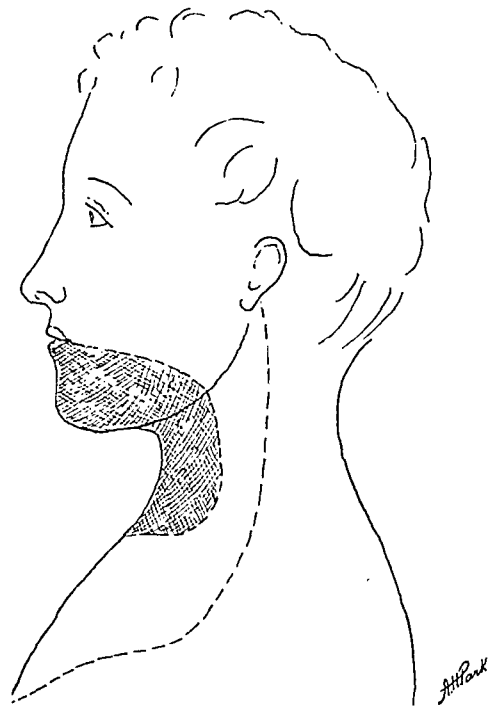


FIG. 2.

be efficient when ignition of the outer investments is responsible for the trouble, as is so frequently the case.

As the burns heal, an unsightly condition develops. The scar becomes elevated into thick, red, longitudinal ridges, due to the stretching incidental to movements of the head and jaw, just as scars hypertrophy on the flexor surfaces of joints and in the axilla after operations for cancer of the breast. Although this deformity is bad enough, it is not the worst. In the course of time the chin is dragged down, perhaps almost to the sternum, the lower lip is everted and the teeth bared. (Fig. 1.)

Such unfortunates are indeed hideous spectacles—their heads tilted for-

<sup>1</sup> Read before the Western Surgical Association, December 9, 1927.

## VISOR FLAPS FROM THE CHEST

ward, their mouths wide open and drooling saliva, their lower lips turned inside-out, their teeth and gums showing, and their almost obliterated necks a mass of red scars and ridges. Even the cheeks and lower lids are distorted by the relentless tension.

It is not easy to correct this condition. It does no good to divide the contracted bands, because as healing takes place the deformity recurs. The first step must be the complete removal of the cicatrix down to the healthy tissues beneath, irrespective of the size of the wound produced. The lip can then be rolled upward into its natural position and the chin brought up to where it belongs. There should be no tension, even when the head is thrown back. (Fig. 2.)

This procedure, in bad cases, leaves a large denuded area extending, perhaps, from the lip to the sternum and more or less extensively from side to side. The problem is to cover this with normal skin so completely that contraction will not recur and the patient will present an acceptable appearance.

The transplantation of small, or even large, epithelial grafts is unsatisfactory, both as regards appearance and the prevention of contraction. Full-thickness grafts are better; but it is difficult to get sufficiently large ones to "take" in this position, although Blair has had considerable success with the method.

Pedunculated flaps, I believe, are preferable to grafts if they are adequately nourished, which often is not the case when the pedicle is single or "tubular" and the flap large. Under such circumstances it may perish or become so thickened and discolored as to be unsightly. These objections do not hold, however, when there are two pedicles, as in so-called visor-flaps.

Some twenty-five years ago I devised a method of operating which has given satisfactory results in four cases. It is only applicable, however, in instances where the skin of the chest is reasonably intact. It consists in the employment of a visor-flap from the upper thoracic region, with its pedicles attached to the sides of the neck in the vicinity of the ears. This, of course, is not a new principle; but as far as the neck and chest are concerned, so little attention has been called to it that I was until recently unaware that it previously had ever been used.<sup>2</sup>

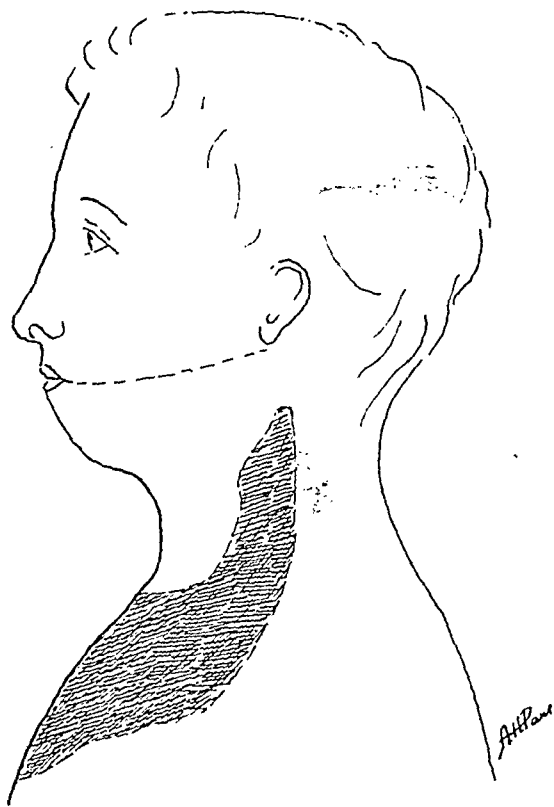


FIG. 3.

<sup>2</sup> Perthes: *Archiv. Klin. Chir.*, 1923, B. 127, s. 165—"Über Visierlappenplastik, etc."

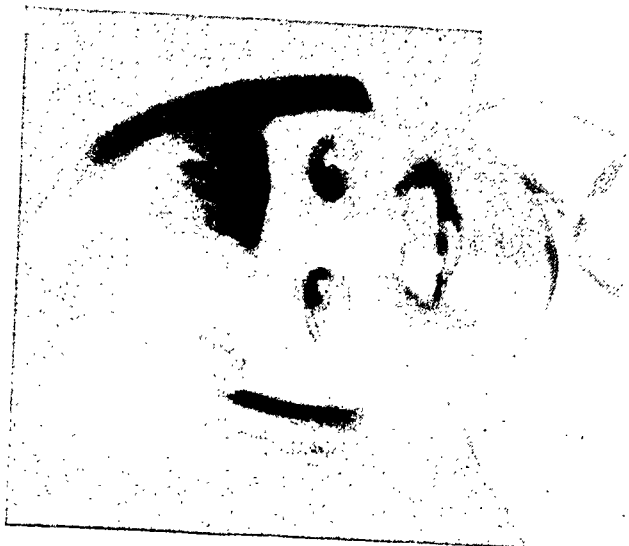


FIG. 6.—Same as Figs. 4 and 5, some weeks after operation.



FIG. 5.—Same as Fig. 4, shortly after operation.



FIG. 4.—Hemangioma involving neck, chin and lip.



## VISOR FLAPS FROM THE CHEST

*Technic.*—After removal of *all* the scar-tissue, so that the lip and chin come easily into their proper positions, even when the head is thrown back (Fig. 2), a flap of the proper size to cover the raw area is loosened from the chest, its upper border being coincident with the lower border of the raw surface to be covered. (Figs. 1 and 2.) The incision outlining the lower margins of the flap should curve upward on each side of the neck toward the ears, far enough from the anterior denuded area to provide



FIG. 7.—Same as in previous figures, several months after operation.



FIG. 8.—Result of visor-flap operation after about fifteen years; the original lesion being a red corrugated scar which had dragged the chin and lip down almost to the sternum, obliterating the contour of the neck.

pedicles an inch or more in width, according to the requirements of the case. (Fig. 2.)

The large flap with its pedicles is then loosened and slid upward so as to cover the anterior part of the neck, and if necessary the chin and lower lip, with a single piece of normal skin. (Fig. 3.) It will be found that the flap and its pedicles usually fit so accurately in their new position that no redundancy has to be adjusted or removed later on.

In order to facilitate closure of the chest wound and also to provide ample skin for the median line of the neck, thus guarding against possible subsequent tension, it is well to curve the chest incision downward into more or less of a tongue. (Figs. 1 and 2.)

The raw surfaces resulting from the lifting of the flap and its pedicles must now be covered, which generally can be accomplished by extensively undermining the adjacent skin—downward on the chest, outward toward the shoulders and axillæ and upward around the sides of the neck. In stretching

the loosened skin into position, stay-sutures passing through large buttons or lead plates are of service.

It will be seen in closing the V-shaped wound over the sternum that the flap is pushed further upward and supported in that position, which is an important feature of the operation. (Fig. 5.) If the wound upon the chest cannot be completely united, it may be skin-grafted; or allowed to cicatrize, removing the scar later by the multiple-stage method by Sistrunk.<sup>3</sup>

In suitable cases it is surprising what a comparatively satisfactory chin, lip and neck may be obtained by a single visor-flap from the chest, the skin being smooth, white, supple and free from scars, blemishes, or tendency toward unsightly thickening such as is seen in insufficiently nourished flaps with a single pedicle. (Figs. 4, 5, 6, 7, and 8.) The only scars which cannot readily be concealed by the clothing are linear ones and mostly horizontal, hence exhibiting little tendency to hypertrophy. In fact, individuals who previously were mere caricatures of humanity, abhorrent to themselves and to others, may be transformed into tolerable, if not handsome, members of society.

H. D. Gillies<sup>4</sup> recommends the use of visor-flaps from the chest with "tubularized" pedicles. Although this may be required at times, especially where the flap must be transferred from a distance, in my own cases it was unnecessary, thus avoiding much post-operative manipulation and producing, I believe, a better cosmetic result.

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<sup>3</sup> ANNALS OF SURGERY, vol. i, 1927, p. 185.

<sup>4</sup> Plastic Surgery of the Face. Oxford Press, 1920, p. 356.

# MALIGNANT DISEASE OF THE THYROID GLAND : A CLINICAL CONSIDERATION \*

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FROM THE SECTION ON SURGERY OF THE MAYO CLINIC

THE prevailing belief is that malignant disease of the thyroid gland is of extreme rarity, and incurable. Many are of the opinion that no treatment is more than palliative. Surgical measures are considered of little avail, and may be even discouraged whenever malignant disease can be diagnosed clinically. Although "cures" following the surgical removal of malignant tumors of the thyroid have been recorded, it has been intimated that in these instances the pathologic diagnosis of malignancy was of necessity erroneous, if the criteria of the malignancy of a tumor of the thyroid are tumor invasion, metastasis and death of the patient. However, the impression gathered in an active thyroid practice has led me to believe that this view is extreme and unnecessarily pessimistic. In order to determine the facts, a study has been undertaken of all the cases of malignant disease of the thyroid in the Mayo Clinic from 1907 to 1926 inclusive. In collaboration with Doctors Broders and Bueermann, I studied the gross and histologic pathology of each specimen removed and classified and graded the neoplasm according to degree of malignancy (Broders); we reviewed and tabulated the histories and made an attempt to ascertain the present condition of each patient. The material for this study includes 276 operative cases and 181 non-operative cases.† The operative list is comprised of those cases in which the surgical specimen was diagnosed by the pathologist, usually at the time of operation; in a few instances, however, the malignant changes were not recognized by the pathologist during the routine examination and were only discovered later when the history of the patient's condition warranted reexamination of the specimen. The pathologic diagnosis of malignant disease of the thyroid is admittedly difficult, even for pathologists long-experienced in lesions of the thyroid, but the errors are chiefly those of omission, that is, failure to recognize malignant disease when present; to-day the trained pathologist seldom makes the mistake of calling a benign tumor malignant. While this study is not yet finished, this paper is based on the clinical analysis of the data revealed. A complete report will be published later.

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\* Read before the Pacific Northwest Medical Association, June, 1927.

† The non-operative cases include all cases of inoperable cancer of the thyroid observed in the Mayo Clinic in the years 1910 to 1926 inclusive. Cases observed in the years 1907, 1908 and 1909 have not been included because the cross-indexes of non-operative cases for these years are not available.

*Pathology.*—During the years 1907 to 1926, inclusive, 276 patients with malignant tumors of the thyroid were operated on at the Mayo Clinic. The lesions have been classified as shown in Table I.

*Etiology.*—Wilson has computed the general incidence of malignant tumors of the thyroid as shown by necropsy records: For Europe 1:224, and for the United States 1:928. The highest incidence was found in goitrous districts; thus Müller and Speese reported the incidence in Berne, Switzerland, 1:93. Data are not available to determine the relative frequency of malignant and benign tumors of the thyroid, as extensive surveys of the incidence of both conditions in large populous communities would be necessary. As Balfour pointed out, the proportion computed from clinic and hospital registrations does not give an accurate ratio, since many of the patients with

TABLE I.

*Malignancy of the Thyroid Gland. Operative Cases, 1907 to 1926 Inclusive.*

	Cases	Per cent.
Sarcoma.....	3	1.0
Diffuse carcinoma.....		25.0
Grade 1.....	0	
Grade 2.....	14	
Grade 3.....	16	
Grade 4.....	39	
Malignant adenoma.....		39.0
Grade 1.....	29	
Grade 2.....	60	
Grade 3.....	16	
Grade 4.....	3	
Papillary adenocarcinoma.....		31.0
Grade 1.....	54	
Grade 2.....	31	
Unclassified*.....	11	4.0
Total.....	276	

\* Tissue not available for reexamination.

the simple nodular goitre never seek medical advice, while all patients with carcinoma of the thyroid eventually come to the physician. In the Mayo Clinic from 1910 to 1926, inclusive, the ratio of malignant tumors of the thyroid to all simple goitres (adenomatous and colloid) was 438:16,110 or 1:36.7 (2.7 per cent.). During the same period the ratio to all goitres (including exophthalmic) was 438:26,310, or 1:60 (1.66 per cent.).

Eighty-one (29 per cent.) of the 276 patients operated on were males, and the remainder, 195 (71 per cent.), were females. In the group of 181, seventy-three (40 per cent.) were males, and 108 (60 per cent.) were females. Malignant disease of the thyroid is more frequent in the female in the proportion of 2:1. A comparison of the sex incidence of all tumors of the thyroid which is 3.5 females to one male, shows the incidence of malignant tumors to be relatively higher in the male.

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The ages (in decades) of the 276 patients operated on were as follows: Two were nine years; six were between ten and nineteen; twenty-four were between twenty and twenty-nine; fifty were between thirty and thirty-nine; seventy-five were between forty and forty-nine; sixty-five were between fifty and fifty-nine; forty-six were between sixty and sixty-nine, and six were between seventy and seventy-nine. The youngest patient was a girl aged seven with a carcinoma in a fetal adenoma; the oldest was seventy-seven. These ages correspond to the age incidence of carcinoma in general; in 69 per cent. the patients were in the fourth, fifth and sixth decades.

In the discussion of the direct predisposing factors of malignant disease of the thyroid gland practically all writers have pointed out the great frequency with which carcinoma has been preceded by the presence of a goitre. It is difficult to obtain accurate information on this point from a study of the history alone. Repeatedly the general examination of patients with hyperthyroidism of long standing reveals the presence of a partly concealed adenoma unsuspected by them. If carcinoma of the thyroid developed in this manner, and unless the malignant growth was definitely encapsulated in an adenoma, it might be erroneously suspected that the carcinoma originated primarily in the thyroid gland. On the other hand, a malignant tumor of the thyroid may develop primarily in the gland and practically remain stationary for a year or two before rapid growth begins. In such instances the origin of the malignant neoplasm would be mistakenly ascribed to an adenoma.

In the series of 276 patients operated on, 224 gave a definite history of a preëxisting goitre of two years' duration or longer. The average duration of the goitre in this group was thirteen and seventy-seven hundredths years. Examination of specimens removed at operation on the remaining fifty-two patients, who had noted the presence of the tumor for less than two years, showed unmistakable evidence of the carcinoma arising in fetal adenoma in fifteen instances. Thus of 276 patients with malignant disease of the thyroid, 239 (87 per cent.) presented unquestionable evidence (conservatively estimated) that the malignant neoplasm originated in a preëxisting goitre. In only one instance in this series did the malignant growth develop in the hypertrophic thyroid gland of exophthalmic goitre.

Symptoms on which the diagnosis can be made definitely are usually not present until the malignant tumor has invaded the capsule of the gland and has become adherent to the surrounding structures. At this time a hard, irregular, nodular tumor, often unilateral, fixed in its bed, with or without cervical involvement frequently associated with hoarseness and paralysis of a vocal cord, a sense of pressure in the neck, dyspnoea and loss of weight is presented; then and not till then is the diagnosis apparent. Unfortunately, now that the diagnosis is obvious, the disease may have advanced beyond the reach of the surgeon.

Of the 438 patients with malignant lesions of the thyroid (operative and non-operative) in the Mayo Clinic in the years 1910 to 1926, inclusive, the

clinical diagnosis of malignancy was made in 237 (54 per cent.). In thirty-nine a tentative diagnosis was made; thus the combined absolute and tentative diagnosis was made in 276 (61 per cent.). Of the 276 patients with malignant tumor diagnosed clinically, only ninety-eight (34 per cent.) were operated on; in the remaining 66 per cent. the tumor was clinically inoperable and surgical procedures were not undertaken. The group of 276 patients presented prominent symptoms as follows: Hoarseness, forty-five (16 per cent.); dyspnoea, 125 (45 per cent.); pressure in the neck, 125 (45 per cent.); paralysis of one or more vocal cords, forty-five (16 per cent.); involvement of the right cord, twenty-three, and of the left, twenty-two; recent loss of ten pounds or more in weight, ninety-two (33 per cent.); and rapid growth of tumor of two years' duration or less, 134 (48 per cent.).

Does malignant thyroid tissue function? Since benign thyroid tissue both normal and abnormal has the peculiar ability of fixing and retaining iodine, Marine and Johnson and later Eisen suggested that the quantitative estimation of iodine in the malignant tumor and its metastatic nodules (as well as in the normal gland) provides a measurable index of its function. The results of their studies showed that the malignant tissue is unable to retain iodine. Since 1918, basal metabolic estimations have been made on eighty-seven of the patients with malignant tumor of the thyroid. Of this number, fifty-three (61 per cent.) recorded rates within the normal limits; thirty-one (26 per cent.) recorded rates elevated from +16 to +81, and three (3 per cent.) recorded subnormal rates of -18, -20 and -30. Thus malignant disease of the thyroid gland does not produce any constant effect on the basal metabolism, and because of the presence of co-existing benign tumors of the thyroid in such a high percentage of cases of carcinoma of the thyroid, it is more logical to conclude that these variations in basal metabolism are influenced more by the benign than by the malignant tumors. It may be concluded, therefore, that the basal metabolic rate is of no aid in the differential diagnosis of malignancy.

In the absence of the characteristic fixed hardness, the presence of any one of the foregoing symptoms is not sufficient to make a diagnosis of malignant disease, but one should always suspect it in any case of goitre in which there is a history of recent rapid growth, and particularly if this is associated with a fixed vocal cord and hoarseness. The paralysis of one vocal cord is not infrequently noted in the laryngeal examination, but unless there is also definite hoarseness, it is of no special significance. But the presence of the combination of hoarseness and paralysis of a vocal cord, in the absence of previous operation on the neck and in the absence of syphilis and a cardiovascular lesion, is almost sufficient evidence of malignancy.

In 276 cases in which operation was performed, a pre-operative diagnosis of malignant disease was made in fifty-six (20 per cent.) and it was suspected in forty-two (15 per cent.), a total of ninety-eight (35 per cent.). In other words, in 65 per cent. of these cases the diagnosis was not suspected

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by the clinician. The surgeon fared somewhat better. A review of the operative findings shows that the surgeon was able to diagnose, or at least suspect, malignant disease in 191 cases (69 per cent.) and was entirely ignorant of its presence in eighty-five cases (31 per cent.). I believe, however, that these figures give too much credit to the surgeon's diagnostic ability, for unquestionably in many instances a supposedly benign goitre is removed, and before the surgeon's observations are dictated, the pathologist has made his report of malignancy; the surgeon then incorporates this data in his own record, unwittingly taking credit from the pathologist.

In the differential diagnosis the lesions most likely to be mistaken for malignant tumor of the thyroid are, diffuse subacute thyroiditis (Reidel's struma), hemorrhagic adenoma, large cystic or calcareous adenoma, and Hodgkin's disease. In any of these, surgical exploration may be necessary to establish the diagnosis. The really important practical point in the differential diagnosis is that clinically it is impossible in a large percentage of cases to know definitely whether a nodular tumor is malignant or benign.

*Metastasis.*—Distant dissemination from untreated carcinoma of the thyroid through both the lymph and blood is common, and is manifested by single or multiple nodules. In many cases these occur apparently early in the course of the disease. In the entire series of 438 cases definite evidence of metastasis was noted on admission to the Clinic in 108 (24.6 per cent.); 105 of these were non-operative and three (cervical involvement) were operative. The most frequent sites of metastasis in the 105 cases were as follows: Regional nodes, seventy-three (69.5 per cent.); lungs, twenty-five (24 per cent.); chest and mediastinum, seventeen (16 per cent.); and bones six. In the others the site was in various parts of the body, such as axilla, liver, trachea, brain, œsophagus, kidney and scalp.

*Treatment.*—In a consideration of the treatment of malignant disease of the thyroid gland the subject must be discussed from three angles: that of the early case, of the late case, and of the benign adenoma (as a precursor of carcinoma). The indications for operation in the presence of known metastasis are exceedingly limited; for example, for relief of tracheal obstruction, and in some instances in which the cervical nodes are involved by milder papillary adenocarcinoma, provided the primary and secondary tumors can be removed without undue risk. Therefore, it can be readily appreciated that the skiagrams of the lungs and bones are necessary in all suspected cases of malignant tumor of the thyroid before surgical procedure is advised.

For convenience of discussion the early case of malignant tumor of the thyroid may be defined as one without extensive fixation to surrounding structures by invasion and without metastasis. The pre-operative diagnosis may or may not have been made, and the operation may have been completed without the surgeon suspecting the nature of the growth. In other words, the carcinoma is confined within the capsule. My convictions are that the removal of all the adenomatous tissue without rupture is ample, and that

an endeavor at complete extirpation of all the thyroid tissue is unnecessary. If the carcinoma is not definitely encapsulated, total removal of the affected lobe is indicated. In all cases a large rubber drainage tube is left in the cavity so that subsequently (twelve to forty-eight hours) radium may be inserted directly into the wound. Later, during convalescence, further topographical applications of radium and Röntgen-ray treatment are indicated. Additional courses of irradiation are advised, depending on the type and degree of malignancy.

The late case is one in which there are varying degrees of fixation of the tumor; therefore operability, so far as the excision of the local growth is concerned, is questionable. Metastasis may or may not be present. If at operation the tumor is found to be resectable, complete extirpation of the lobe is indicated with supplemental courses of external irradiation and Röntgen-ray treatment. If the local growth cannot be removed at operation, radium needles (ten to twenty) may be buried about 1 cm. apart, in the tumor by means of steel-alloy points containing 10 mg. of radium sulphate each (Bowling). Silk threads are attached to the needles so that the operative wound may be closed and the needles removed aseptically within twelve to twenty-four hours. Further irradiation is given during the convalescent period and subsequent courses of treatments every two or three months. In this manner the local tumor is often made to disappear or is kept under control, and not infrequently deep metastatic nodules are diminished remarkably. Probably in no other malignant disease are radium and the Röntgen-ray so valuable as in the treatment of malignant tumors of the thyroid. Cures by irradiation in such cases can hardly be expected, but reducing the size of the tumor, and extending the patient's life by from two to four years is not uncommon. Since 1918, operation in conjunction with irradiation has been employed in the Mayo Clinic, as outlined here, in most of the cases of carcinoma of the thyroid gland coming to operation.

In view of the fact that carcinoma of the thyroid develops in from 80 to 90 per cent. of cases in a preëxisting benign adenoma, and in view of the known frequency of carcinoma of the thyroid, should all adenomatous goitres be considered precursors of carcinoma, and their removal urged? That the retention of adenomatous goitre entails a certain risk of carcinoma cannot be denied. The extent of the risk cannot be estimated accurately in the light of our present knowledge of the actual and relative incidence of benign and malignant tumors of the thyroid. I believe, however, that this danger is sufficient to be taken into account in formulating an opinion as to the advisability of the removal of a simple nodular goitre, and in view of the exceedingly low operative risk and morbidity, and the very small incidence of recurrence after operation in patients aged thirty years or more, I believe that we are warranted in stating the facts to the patient and advising operation. When this danger is considered in conjunction with the other potentialities of a retained adenoma, that is, development of hyperthyroidism and extension of



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the growth, I believe that with proper hospital facilities and in the absence of specific contra-indications, we should urge the removal of all adenomatous goitres.

*Results.*—Statistics on the results from operation for carcinoma, to be of any value, must be based on the condition of the patient at least three years after operation. In analyzing the results in this series, the cases in the last three years (1924, 1925 and 1926) have been omitted. Of the 205 patients in the series, sixty-six (32 per cent.) are known to have been alive in November, 1926, a period of from three to eighteen years (Table II).

The end results are influenced by the type and degree of malignancy. Of

TABLE II

*Patients Operated on for Carcinoma of the Thyroid, 1907 to 1923 Inclusive*

	Patients	Living *	Per cent.
Sarcoma.....	1		
Diffuse carcinoma.....			21.0
Grade 2.....	7	1	14.0
Grade 3.....	12	3	25.0
Grade 4.....	32		
Malignant adenoma.....			38.7
Grade 1.....	14	9	64.0
Grade 2.....	49	18	36.0
Grade 3.....	15	3	20.0
Grade 4.....	1	1	100.0
Papillary adenocarcinoma.....			48.0
Grade 1.....	42	20	47.0
Grade 2.....	22	11	50.0
Unclassified.....	9		
Total.....	204	66	32.0

\* Recurrence in a few cases.

the nineteen patients with diffuse carcinoma, four (21 per cent.) are living. Of the eighty patients with carcinoma in fetal adenoma, thirty-one (38.7 per cent.) are living. Of the sixty-four patients with papillary adenocarcinoma, thirty-one (48 per cent.) are living. During the period from 1907 to 1921, inclusive, it is found that of the 167 patients operated on seventy-one (42 per cent.) lived for five years or longer, although it is known that some of these "cured" patients died subsequently, a few from recurrence of the malignant disease.

Because of the oft-repeated statement that surgical procedures are of no value in cases of carcinoma of the thyroid in which the diagnosis can be made pre-operatively, it is of considerable interest to check the actual results. In the seventy-six cases of carcinoma of the thyroid gland (1907 to 1923) in which carcinoma was diagnosed or suspected pre-operatively, twenty-five

(32.8 per cent.) of the patients lived for three years or longer; eight are still alive, after a period of from three to eight years; in one case it is known to have recurred. In two cases, resection of the malignant tumor and excision of cervical nodes involved by metastasis were carried out. Both patients are well, four and five years after operation.

## SUMMARY

The clinical study of 457 cases of malignant disease of the thyroid (276 operative and 181 non-operative) may be summarized as follows: The frequency of carcinoma of the thyroid as compared with benign nodular tumors is 1:36.7 (2.7 per cent.) as compared with all benign enlargements, 1:60 (1.66 per cent.). The age incidence corresponds to that in cases of carcinoma in general; 69 per cent. of the operative cases were in the fourth, fifth, and sixth decades of life. The malignant lesion predominates in the female in the ratio of 2:1. In 87 per cent. of all the cases there was definite evidence of a preëxisting benign goitre. Pathologically, the malignant tumors were classified as sarcoma 1 per cent., diffuse carcinoma 25 per cent., carcinoma in fetal adenoma 38 per cent., and papillary adenocarcinoma 30 per cent. Even in the absence of the characteristically hard, irregular nodular tumor fixed to the neighboring tissues, malignancy should be suspected in all tumors of the thyroid in which there has been recent rapid growth, with or without associated hoarseness and paralysis of a vocal cord. The clinician suspected the malignant nature of the tumor in only 35 per cent. of the operative cases and the surgeon suspected it in 69 per cent. Metastasis occurs through the lymph and blood. It occurs frequently, and often early in the course of the disease. The most frequent sites of secondary involvement are: regional nodes 69 per cent., lungs 24 per cent., chest and mediastinum 16 per cent., bones 6 per cent. Operation supplemented by irradiation is the choice of treatment. The adenoma must be looked on as a precursor of malignancy, although the danger entailed by the retention of an adenoma cannot be computed; it is not over 2.7 per cent.

The results of the surgical treatment of carcinoma of the thyroid are more encouraging than is popularly believed: of the 204 patients operated on during the years 1907 to 1923 inclusive, sixty-six (32 per cent.) are living after a lapse of from three to eighteen years. These results are influenced for the most part by the type of the growth and the grade of the malignancy. Of those with sarcoma, none is alive; of those with diffuse carcinoma, 21 per cent. are alive, with carcinoma in fetal adenoma, 38 per cent., and with papillary adenocarcinoma, 48 per cent. In the cases in which malignant disease was diagnosed before operation, 32 per cent. of the patients are living three years or longer.

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# TONSILLECTOMY WITH BLOODLESS TECHNIC

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THERE are as many methods of removing tonsils as there are operators. All have varied technic and good reason for such procedure. However, their end results differ only in the number of complications. It seems that lung abscess and hemorrhage are the captains of complications. The most logical method in preventing the complications is to eliminate the cause, which is bleeding.

Before describing the operation, the instruments used in this procedure are listed first, viz: 1. Endothermy machine. 2. Mouth gag. 3. Tyding's snare, or any snare that can be insulated. 4. Murphy's double-edged dissector. 5. Insulated clamp. 6. Tenaculum.

1. *Endothermy Machine*.—Three types have been tried and all give satisfaction. The inactive electrode used is made of meshed copper.

2. *Mouth Gag*.—I am more familiar with the Davis type of gag. Any type is suitable, depending on the preference of the operator.

3. *Tyding's Snare in Diagram*.—Any snare can be used that is easily insulated. The insulation should extend at least one-eighth of an inch beyond cylinder where the wire protrudes. All parts coming in contact with patient's mouth must be insulated.

4. Double-edged dissector or knife depending on preference of the operator.

5. *Insulated Clamp*.—The entire clamp is insulated excepting the tip, so that when the current is applied, only that part of the tissue grasped with the end of clamp is coagulated.

6. *Tenaculum*.—Any heavy instrument with at least four teeth allowing a firm grasp can be secured, permitting strong traction.

The entire tonsil is to be removed with its capsule intact. The tonsil is freed from its pillars by dissection and finally severed from its connection to its bed with the electrical snare.

The operation should be preceded by an examination of heart, lungs, urine and blood-clotting time. Atropine 1/150 gr. to all patients over ten years of age. It is well to see that the teeth are in good condition and clean.

*Anæsthesia*.—Ether not to exceed second stage. Adult patients are started with gas and oxygen and switched to ether. All patients should be put to sleep in a room especially prepared for such procedure. Before applying current to snare, the patient should have fifteen expirations.

*Position*.—Recumbent on a narrow table. If a metal table, have a thick pad between patient and table, preferably have the table insulated with rubber mats or tires. For this reason the average operating room carriage serves the purpose well.

## TONSILLECTOMY WITH BLOODLESS TECHNIC

*Landmarks.*—The contour of the tonsil and the anterior and posterior pillars and the fauces.

*Electrical Technic.*—The mesh electrode, 4 x 10 inches, is dipped in thick green soap. The smooth side wrapped snugly about the arm with an elastic bandage. (Fig. 1.) The inactive wire is attached to the mesh electrode by means of a metal clasp. Always attach clip to external surface of arm electrode, not allowing it to come in contact with patient's arm (see Fig. 1), preventing possible burns.

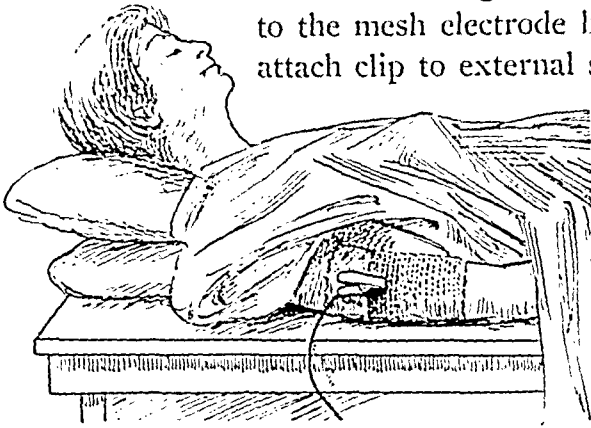


FIG. 1.—Inactive electrode applied to arm. The clasp attachment insulated from patient's arm by gauze bandage.

The current used in this operation is of the bipolar d'Arsonval damped type, produced by an apparatus consisting of a transformer, spark gap and Oudin coil. The active electrode is the tonsil snare and the inactive one a brass mesh strapped to the arm. The

current used has two qualities, first cutting, second coagulation. The former is obtained by closely approximating the points of the spark gap. Coagulation is obtained by adjusting the transformer to the desired capacity. When beginning to use a new machine, one should test the various settings of the transformer and spark gap to determine the depths of penetration of the different strengths of currents. The ideal current is a cutting current which will coagulate the tissues to a depth of about one-half to three-quarters of a millimetre on each side of the snare. This leaves a white film over the tonsil fossa, preventing bleeding. The snare should be contracted slowly but steadily in order to insure an evenly distributed effect, but rapidly at any point, giving rise to

*Operation.*—The tonsil is seized with a tenaculum and drawn toward the median line. The dissector for denuding the mucous membrane is inserted to the depth of one-fourth of an inch between the anterior pillar and tonsil, cutting at the junction of the anterior pillar and the tonsillaris, where the tonsil is not adherent and is generally readily demonstrated with the tongue well depressed. (Fig. 2.) The dissection is carried upward along the anterior aspect of the tonsil and then over the marginosuperiotonsillaris to the posterior pillar. By passing above the marginosuperiotonsillaris, the part of the tonsil in the supratonsillar fossæ is freed. Drawing the tenacu-

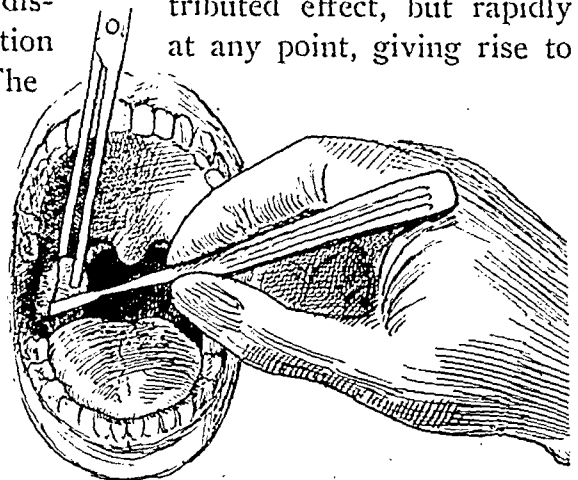


FIG. 2.—Separating the anterior pillar from tonsil. Same procedure on posterior surface.

lum forward exposes the posterior aspect of the tonsil. The knife is now turned to sweep backward and downward, freeing the posterior pillar from the tonsil, always cutting toward the midline and away from the tonsil. The wire of the snare is slipped over the handle of the tenaculum. Strong traction is made on the tenaculum, dislodging the tonsil as much as possible from its bed toward the midline. The snare wire is bent to a right angle, and slipped beneath the pillars, the curve of the wire over the top pole and the base of the snare below the lingual tonsil, gradually depressing the handle of the snare, tightening the wire about the base of the tonsil. (Fig. 3.) The current is turned on by means of a foot switch, the handle of the snare being depressed, letting the current cut through the tonsil. The tonsil comes away, leaving a clean dry field, being covered by a gray, thin film of coagulation.

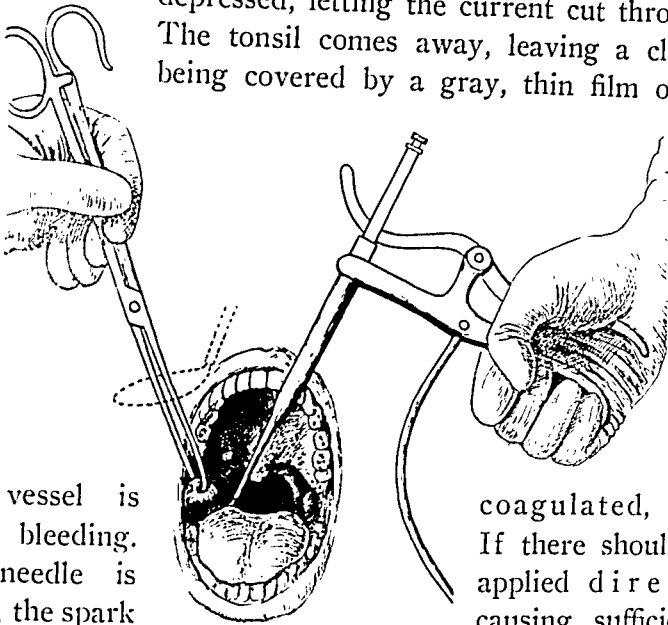


FIG. 3.—Application of snare. All parts insulated coming in contact with patient's mouth.

Occasionally there will be a small bleeding point, especially in cutting through this bleed-clamped insulated scar tissue. This bleed-clamped insulated touching the same current on the coagulated, immediately stopping the bleeding. If there should be a small ooze, the needle is applied directly to the bleeding point, the spark causing sufficient charring to prevent further bleeding. These difficulties are seldom and much less frequent after one becomes accustomed to the machine and the type of tonsil which is being removed. **Hemorrhage.**—Primary and secondary hemorrhage has been one of the most frequent and serious complications of tonsillectomy. Doctor Gerald Hutchinson Cox (*N. Y. State Medical Journal*, April, 1925) collected and reported 261 severe tonsillar hemorrhages; one hundred and twenty-five fatal. He concludes that the most frequent cause of tonsillar hemorrhages are traumatism at operation and neglect to secure a dry field by ligating all bleeding points. In using the electrical snare, there is no primary hemorrhage and very little trauma, avoiding the big dangers of the cutting operation. In only six cases out of three hundred has there been any post-operative bleeding. Four of these cases reported two weeks after operation for examination, gave a history of expectorating a small amount of blood-stained sputum after eating solid food. Two of the six cases reported to the hospital oozing a small amount of blood from the granulating area in the region of the lingual tonsils. One case reported eleven days and one eight days following opera-

tion. Neither of the cases had much bleeding and were easily controlled with a stypec. In all of the post-tonsillar oozing, the lingual tonsils had been removed by coagulation with the needle after the faucial tonsil had been removed with the snare.

Lung abscess following tonsillectomy cannot be dismissed without much consideration when reports from the Mayo Clinic, 1924, that 31 per cent. of lung abscess followed tonsillectomies. Chevalier Jackson in the *Atlantic Medical Journal*, February 26, 1927, writing on the subject of post-tonsillectomy pulmonary abscess, says Myerson found blood bronchoscopically in 76 out of 100 cases of tonsillectomies. As the source of blood was from the tonsillar field of operation, the inference is justified that the blood carried infected material from the tonsil. If we have no blood at the time of operation, we completely eliminate this possibility.

Another feature of this type of tonsillectomy is the small amount of post-operative pain. In a number of adult cases, one tonsil was removed by blunt dissection and the other with the electrical snare. Invariably, the patient complains of more pain on the side removed by blunt dissection. It was then thought that the trauma to the tissue played a part in post-operative pain, so a number were removed with the snare without any current. Without fail, the patients complained of more pain on the side where no current was used. It is hard to say just why a coagulated base gives less pain than a cut one, but the theory that the nerve endings have been coagulated rather than left exposed is undoubtedly a good one. Be that as it may, the fact remains that they do have less post-operative discomfort with this method.

Over 90 per cent. of the 300 cases reported for examination, one week after operation, at that time, the fossæ was covered with a soft yellowish membrane. Swelling and œdema are practically negative. Two weeks after operation, only 54 per cent. reported for examination. At that time, the fossæ was clean and there was no discomfort. Three weeks after operation, only 29 per cent. reported for examination and at that time the throat was healed.

Of 300 cases there has not been a single complication except six bleeding cases mentioned previously.

To determine the depth of penetration of the current, numerous sections were made from picked and routine cases. The average is about 4 microns.

# PRIMARY SARCOMA OF THE CLAVICLE

By LEWIS BARCLAY BELL, M.D.

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PRIMARY sarcoma of the clavicle is a rare condition and when it does occur, it is as a rule rapidly fatal. The case reported herein is one in which the patient is living three years after the removal of the sarcoma. Careful perusal of the literature reveals only seven cases in which the patient lived three years or longer.

*Case Report.*—Miss E. S.,\* seventeen years of age, noticed a hard, marble-sized lump on her right clavicle two months before presenting herself for examination. This lump was tender to pressure and painful whenever the arm was moved quickly. The patient complained of slight dizziness and weakness. She had lost about ten pounds in weight. The mass had grown rapidly larger and became softer and more tender, so that on May 19, 1924, it measured 7 cm. in length, 3 cm. in width, and 3 cm. about the clavicle. It was a smooth lemon-shaped enlargement involving the middle third of the right clavicle. The overlying skin was of normal color and was freely movable over the underlying structures. The mass seemed to be an integral part of the clavicle. It was soft and fluctuating in the central portion. Aspiration secured about 3 c.c. of dark red blood, indicating a possible angiosarcoma.

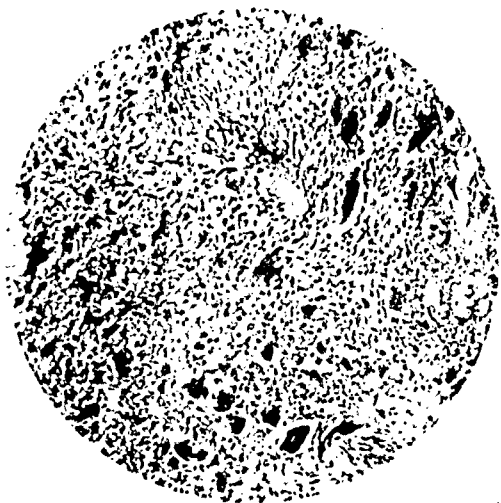


FIG. 1.—Section from tumor showing spindle cells and osteoclastic giant cells. Small spicules of bone are present in this section (x 140).

General examination revealed nothing to suggest syphilis or tuberculosis. There was no fever; the leucocyte count was 9000, the red count was 4,040,000, and the urine showed neither albumen nor sugar. The Wassermann test was negative. Family history recorded no tuberculosis or malignancy. Preceding the appearance of the growth, however, there was a definite history of trauma as a relative had frequently struck her violently about the head and shoulders in his fits of ill-temper.

Röntgenological examination showed the tumor mass, an area of partial destruction of the clavicle and apparently a distinct reflection of the periosteum up over the tumor mass proper. These findings pointed strongly toward a diagnosis of bone tumor. There was no bony capsule that would have suggested osteitis fibrosa cystica.

On May 19, 1924, under ether anæsthesia, I excised the entire clavicle and tumor in the following manner: An incision was made the full length of the clavicle following the midline of the bone over the tumor. The skin was dissected back, the muscle insertions were removed, and the periosteum was freed all around the normal portion of the clavicle. Then with a rib-cutting gullitome the bone was divided 3 cm. proximal to the new growth. The distal portion with the tumor was elevated and disarticulated, and

\* The case of Miss Evelyn Smith sent for registration has been given No. 823 of the Registry of Bone Sarcoma series and classified as an Osteogenic Sarcoma.

The last note we have as to patient's condition is that on April 12, 1927, she was working every day and feeling fine. Broman C. Crowell, Registrar, Committee on Bone Sarcoma, Depart. Clin. Research, Amer. Coll. Surgeons, Dec. 13, 1927.



## PRIMARY SARCOMA OF THE CLAVICLE

the other segment was likewise removed. The remaining portion of the periosteum was carefully dissected off, leaving only that part lying over the great vessels near the sternum. There was no bleeding. A small gauze drain was inserted. The skin was closed with interrupted silkworm-gut sutures. At the end of twenty-four hours the drain was removed. The large dressings were saturated with serum but the wound healed by first intention. Recovery was uneventful and the patient left the hospital on the fourth day after the operation.

The specimen was examined by Dr. H. R. Fishback, who reported as follows:

*Gross Description.*—The specimen consists of a clavicle 15 cm. in length and of normal contour except for an enlargement of the shaft beginning just outside the sterno-clavicular articulation. This mass projects downward and posteriorly, filling in the arc of the first curve of the clavicle. The mass is spheroidal, extending along the bone 5.5 cm. and being 3 cm. in diameter at its thickest portion. The upper and anterior portion of the wall is composed of the thinned shaft of the bone which is unchanged externally. The wall of the projecting mass is about 1 mm. in thickness and is fibrous in character. Many small bony deposits are found in this.

The enclosed tumor mass is friable and pinkish-red in color. Some areas are soft and almost jelly-like, while others are firm and show considerable connective-tissue stroma. There are areas of hemorrhage into the structure. The tumor can be pulled from the bone rather easily and exhibits small projections into the cancellous spaces of the bone. The bone surface shows absorption. No gross extension through the capsule is made out, and there is no extension into the bone shaft beyond the area of widening.

Paraffin sections of the tumor were made and stained with hæmatoxylin and eosin. Some sections which included portions of the bone shaft were decalcified.

*Microscopic.*—The tumor tissue is generally of rather loosely placed cells of predominant spindle form, with many irregularly set giant cells and much blood, both diffused through the tissue and enclosed in blood channels. No bone formation is seen in the tumor proper.

The spindle cells vary from young cells of varying form, with hyperchromatic nuclei and an occasional mitotic figure, to older cells of thin spindle form associated often with mature connective-tissue fibrils. The younger cells are found often in rather large groups with a rich blood supply. In these groups also are found most of the giant cells. They are variable in size up to 25 micra and show an opaque cytoplasm with many separate small oval nuclei, which tend to central location in the cell.

There are many blood channels, some of which are quite large and show intercommunication, giving the appearance of a telangiectasis. Many of the channels show no differentiated wall, the blood being present in clefts of the tumor tissue. Giant cells appear in these blood channels occasionally free or hanging by delicate fibrous filaments, or projecting from the wall into the lumen of the channel.

Sections from the capsule show a fibroblastic structure of varying stages of development up to hyalinization. The younger portions have a free blood supply. Externally, the fibroblastic tissue is found encroaching on the muscle, with little islands of atrophic muscle fibres enclosed by connective tissue. The inner surface of the

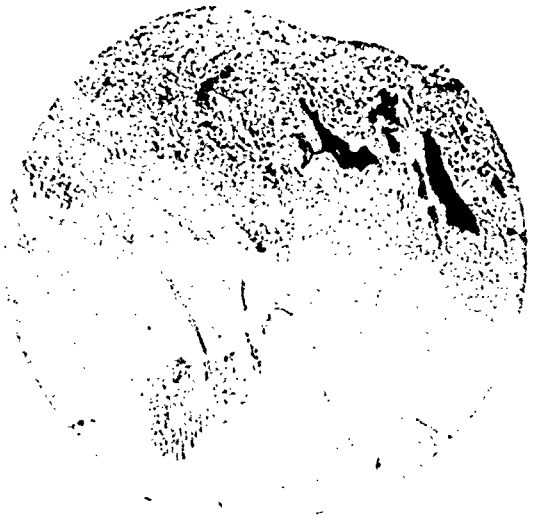


FIG. 2.—Section showing margin of tumor with two small hemorrhagic areas and an underlying degenerative process in which are spicules of bone (X 27).

capsule has areas of typical tumor tissue and many small spicules of bone. The bone is enclosed by the fibroblastic cells, and much of it is of new formation. There is a slight infiltration of lymphocytes in and about the capsule. No extension of the tumor through the capsule is found, nor into the bone beyond the area of widening of the shaft.

*After-history.*—Following operation there seemed to be no loss of function; in fact, the patient noticed no difference in the use of the right arm from that of the left arm.

It is now three years since the operation and there is no evidence of recurrence or metastases. The patient has gained in weight and feels well. Röntgenological examination showed regeneration of the inner half of the clavicle from the periosteum that was left near the sternum.

*Comments.*—The literature of sarcoma of the clavicle centres around the name of W. B. Coley, whose careful reports and collection of cases comprise

the great bulk of the subject matter extant. In 1910, Coley reviewed the literature mentioning 32 cases of Norkes in 1893, added 20 from the literature, and reported 12 cases not previously written up, making a total of 64 cases of sarcoma of the clavicle. Again in 1920, Coley added 32 cases found in print by Johansson and three cases under his observation, two cases reported by Kalus, and five of his own, making a total of 106 up to 1920.

Of the 64 cases collected in 1910 only three were known to have been cured, one well for fifty years, one

for ten years, and the third for five years. Since then four more cases treated by total excision plus Coley's mixed toxins of erysipelas and bacillus prodigiosus were reported as living: Delatour's case, five years; Coley's case, three years; Richardson's case, five years, and Huntington's case, four and one-half years.

Coley reports some very interesting cases—that of Freeman, a male, age twenty-three, who had a periosteal round-celled inoperable sarcoma which became operable following the use of toxins and X-ray and who was living ten years at the time the report was made; that of S. L., female, age twelve, a clearly operable case in which the value of radium was tested by five treatments together with X-ray. The tumor decreased in size but metastases formed in the lungs and the patient died within six months of the onset of the first symptom, no microscopic diagnosis having been made; that of Pincy of the Radium Institute of London, a female, sixty-two years of age, who had a large rapidly growing periosteal round-cell sarcoma in which operation was refused. The tumor was treated with radium and the patient was well two years later. He cites two of his own cases on the borderline of operability which were treated with radium and mixed toxins and followed by metastases and death in six months. One inoperable case (King's) was treated with radium and toxins, but the patient succumbed. One advanced case was given mixed toxins with no effect and death followed in six months. Three cases of periosteal round-celled sarcoma are reported, one of which



FIG. 3.—Section from near sterno-clavicular joint showing cartilage, fat, and tumor tissue. Two blood-vessels show in the section (x 40).

## PRIMARY SARCOMA OF THE CLAVICLE

treated by excision and toxins resulted in a cure lasting nine years at the time the report was made; another similarly treated was well after twelve years, and one patient treated by excision and toxins died in a few months. Coley emphatically advises total excision and prophylactic after-treatment with mixed toxins in all cases.

Beatson, in 1902, reported a case of small round-cell sarcoma, the patient being alive and well two years after excision.

Sutton, in 1906, reported a patient well after seven months following partial excision.

W. Martin, 1921, N. B. Carson, 1911, F. W. Wunderlich and R. F. Fort have each reported a case of excision with no definite history of recovery for any stated period.

The most recent case appearing in the literature is reported by Coley in 1925, an endothelioma treated by total excision, toxin, and radium, but proving rapidly fatal.

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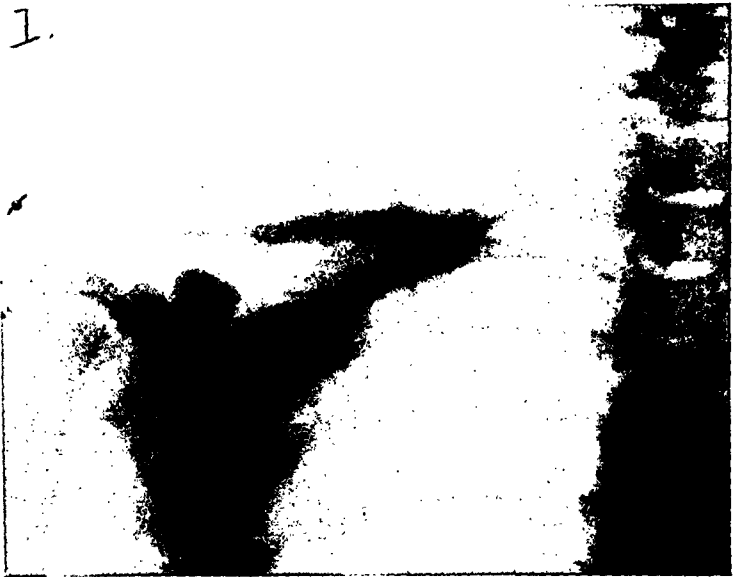


FIG. 4.—X-ray showing tumor mass and periosteum reflected up on to it.

The records show very incomplete data as to microscopic pathology. This is most unfortunate considering the high mortality and the great discrepancies in the results of surgery, radium, X-ray and mixed toxin treatment.

Nine were round-celled sarcomas, some of which recovered; one spindle-celled died; and one angiosarcoma that was operated on became inoperable and probably died.

Of the 106 cases reviewed by Coley we know of only seven cases that are living from three to fifty years.

Murphy emphasized the rareness of primary sarcoma of the clavicle in his summary of 797 cases of bone sarcomata



FIG. 5.—Röntgenograph taken September 13, 1927, showing regeneration of inner half of clavicle but no evidence of bone pathology.

collected from the literature in 1914. Of this number the clavicle was involved in only three-tenths of one per cent.

Credit for the first total resection of the clavicle for sarcoma is given by Coley to V. Mott in 1828, whose impression of the operation is best given in his own words: "This operation far surpasses in tediousness, difficulty and

danger anything that I have ever witnessed or performed. It is impossible for any description which we are capable of giving to convey an accurate idea of its formidable nature." History seems hazy on the subject of priority, for Remmer in 1732, Merean and D. Angerville, of Paris, in 1765, McCreary, of Kentucky, in 1811, and Meyer in 1823 are each said to be the pioneer.

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## SOME UNDERLYING PRINCIPLES OF INTESTINAL SURGERY\*

By J. SHELTON HORSLEY, M.D.

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THE mechanical features of an operation are, of course, important, but when chief consideration is given to the kind of sutures used, to the pattern of the scissors and the shape of the forceps, they are unduly glorified. One of the great improvements in surgical technic was the introduction of absorbable sutures. This has been hailed far and wide as one of the big advances in operative surgery. Yet surgeons in certain prominent schools use silk almost invariably, thus showing that fine silk can be properly employed with satisfactory results. Even operative skill, as desirable as it is, may be emphasized over-much. There is such a thing as the operator being intoxicated with his own dexterity, which may on some occasions overbalance his best judgment of the procedure to be employed. These things are important—surely no one should deny the importance of operative dexterity—but they do not loom so large as they did in the pre-antiseptic era, and the increasing comprehension of modern physiology and biology has relatively diminished the importance of the mechanical features of an operation.

The normal function of any organ or viscus must be understood before an intelligent attempt at repair of its disordered function can be made. In the gastro-intestinal tract there are three more or less distinct functions, and a serious or prolonged interference with any one of them may result fatally: (1) The function of digestion, in which food is prepared and properly mixed with the secretions of the stomach and intestine, so that it is in a condition to be assimilated; (2) absorption, by which digested food is distributed through the lymph and blood-vessels to the bodily tissues; and (3) the function of peristalsis, by which the food is propelled from one part on the intestinal tract to another. This latter function overlaps and aids both digestion and absorption, and has other uses besides. For instance, Werelius, of Chicago, thinks that the cause of death in obstruction of the bowel is due to hepatic insufficiency, from stagnation of the portal circulation on account of the abolition of peristalsis by the obstruction; for the portal circulation depends largely upon the activity of the intestinal muscles.

Several decades ago all small intestines were supposed to look very much alike, and even differentiation in function was vague. Largely due to the work of Monks and others, we know that there is a different anatomical appearance of the upper small intestine from the lower ileum, and physiologists have pointed out that there is even a greater difference in function. Studies by Alvarez, Kline and others have thrown much light upon the motion of the small intestine. The beautiful moving pictures of intestinal

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\* Read before the Society of Alumni of Bellevue Hospital, New York, December 7, 1927.

peristalsis taken by Alvarez demonstrate his own views. According to Alvarez there is a gradation of peristalsis from the upper small intestine to the lower small intestine. Strips of muscle without nerve tissue from the upper jejunum when placed in oxygenated Locke's solution with strips from the lower ileum show a distinctly quicker rate of contraction.

Any extensive discussion of intestinal obstruction would carry us too far afield, and yet this condition cannot be ignored in considering the underlying principles of intestinal surgery, because upon the conception of obstruction depends the kind of treatment that must be given. It is well known that obstruction in the upper intestinal tract is more rapidly fatal than obstruction in the lower intestinal tract, even when the obstruction is of the same type. This has been partly explained by more rapid dehydration in high obstruction. In fact, some surgeons think that dehydration is the chief if not the only danger in high obstruction over the dangers of low obstruction. Doubtless, too, the more sensitive muscle in the upper small intestine may become exhausted from over-stimulation, whereas the slower, more phlegmatic muscle in the lower intestine may take things somewhat easier and so last longer.

It has been demonstrated that it takes a smaller degree of compression in the upper small intestine to produce an obstruction than in the lower small intestine or in the colon. This may be due to the fact that the increased sensitiveness and activity of the upper small bowel is more susceptible to pressure influences and resents irritation so that spasm may occur in addition to the mechanical pressure. At any rate it is clinically obvious that a degree of closure of the lumen of the bowel that would cause marked symptoms in the upper small intestine will produce but little disturbance in the colon or in the lower small intestine.

Intestinal obstruction has too frequently been considered as a general term without differentiation as to the type or locality of the obstruction. Aside from the well-known clinical fact that upper obstruction is more serious than lower obstruction, the type of obstruction has been often ignored. Foster and Hausler have done an excellent piece of work in calling attention to the radical difference between a simple mechanical obstruction due, for instance, to bands of adhesions or to a growth within the bowel, and an obstruction involving strangulation or interference with the vascular circulation of the intestine. The latter type, as a volvulus, is usually rapidly fatal and requires prompt surgical treatment, often demanding resection of the affected loop. The toxic material that appears to be formed within the bowel wall seems to resemble to some extent the histamine-like products that cause shock. This material produces profound symptoms,—a rapid weak pulse, fall in blood-pressure, vomiting, cold clammy skin, and many of the phenomena of shock. A simple mechanical obstruction, on the other hand, due to a band or to a growth from the bowel, causes some pain and increased peristalsis, but, as is well known in cancer of the colon, may gradually encroach upon the lumen of the bowel until there is complete obstruction for days without causing alarming symptoms. There is an intermediate type of cases

## SOME UNDERLYING PRINCIPLES OF INTESTINAL SURGERY

in which the segment of bowel that is involved is short, and in which there is not enough toxic material evolved by the comparatively small area of the bowel affected to produce sufficient toxic products to cause the shock-like symptoms of obstruction. Here there may be a combination between mild shock-like symptoms and the symptoms of mechanical obstruction. John A. Hartwell and his associates years ago pointed out that what is at first pure mechanical obstruction, as from a band, may from excessive peristalsis and distention involve the vascular circulation and so take on the features of strangulation. This is more likely to occur in the small intestine—particularly in the upper small intestine—than in the colon.

In post-operative obstruction due to lymphatic adhesions, the condition resembles at first the type of mechanical obstruction without strangulation of the bowel. After operations, however, the resistance of the patient may already have been lowered by the operation and the anæsthetic. The constant regurgitation and vomiting of liquid fecal matter will rapidly dehydrate the patient, as the obstruction is usually in the small bowel. A simple enterostomy with the insertion of a rubber catheter will often relieve the situation. Whether the enterostomy should be done low in the small bowel or high in the jejunum is a moot point. Following the teaching of Victor Bonney, Lee and Downes, Donald McRae and others, some surgeons have been advocating the performance of an enterostomy high up in the jejunum. But Orr and Haden in their experimental work emphasize the fact that dogs with experimental obstruction die sooner when the enterostomy is done high in the jejunum than if no enterostomy is done at all.

It would seem best to evacuate the bowel as near the site of obstruction as possible without too much manipulation. If there is a further obstruction on the oral side another enterostomy may be done higher up. As long as the enterostomy is done by the method of Coffey or of Witzel, with a soft rubber catheter, the danger of starvation with the enterostomy in the upper jejunum is avoided. The bowel should not be brought into the wound and opened freely for obstruction unless there is gangrene or marked impairment of the circulation in the loop.

The contents of the intestines also vary markedly from the duodenum and the upper jejunum to the ileum and colon. In the upper jejunum with its rapid action and quick emptying the contents are almost sterile. The antiseptic effect of the hydrochloric acid in the gastric juice is pronounced. Consequently the spilling of fecal matter in the upper small intestine is a question of not so great moment as in the lower small intestine or colon where the slightest soiling of the peritoneum with fecal matter may bring disaster.

These facts, then, indicate a relatively different biologic condition in the upper small intestine from what is found in the lower small intestine or in the colon, and it is necessary to fit our surgical technic accordingly. We may use different surgical materials, vary the instruments and the type of needles and clamps, but we cannot buck against the biologic laws governing living

tissue. It is essential in the upper small intestines to provide a good lumen because of the fact that obstruction here is not only more readily produced but is more rapidly fatal than in the lower bowel. Then, too, the fact that the contents of the upper small intestines are poor in bacteria or are almost sterile will permit the opening of the bowel in this region with comparative impunity. As to the relative merits of end-to-end or lateral anastomosis, if the end-to-end anastomosis can be performed with the same safety as lateral it is preferable. Undoubtedly the incision of the circular fibres in lateral anastomosis puts out of commission that segment of bowel so far as peristalsis is concerned, and it acts to a large extent as a foreign tube. Blake and Cannon have shown in experiments years ago that a bismuth meal in intestinal anastomosis on animals will pass through an end-to-end anastomosis satisfactorily, but that almost always there was a residue left in the segment in which a lateral anastomosis was done. In the course of time, however, the lateral anastomosis seems to rearrange itself in such a manner as almost to simulate the opening of an end-to-end union, so that the amount of material left within the site of this anastomosis is comparatively small. The chief danger of the lateral anastomosis is leaving pouches at the ends where material may accumulate and cause trouble. The stoma should be carried well toward each end, particularly toward the oral end of the bowel.

As the triangular space where the mesentery spreads to cover the bowel is rich in lymphatics and areolar tissue, it is important to avoid carrying infection to this region. The mesentery should be opened, clamped and tied well up to the bowel before the bowel is opened, and then it would be better to open the bowel from the mesentery toward the convex portion of the bowel. Even in the upper small intestine this precaution should be taken.

It is highly important in the upper small intestine to preserve the lumen, so here it would be best to do the operation by an open method, using soft-bladed clamps or rubber bands to prevent fecal flow, dividing and tying the mesentery and dividing the bowel from the mesenteric border outward somewhat obliquely in order to obtain maximum nutrition for the united ends. A row of continuous sutures is begun a short distance from the mesenteric border, passed as a mattress suture and tied on the lumen of the bowel. The mesenteric borders of the ends of the bowel are arranged so as not to be exactly opposite but to lie side-by-side. This suture is continued as a continuous mattress suture, is drawn quite snugly, and when a third of the bowel is sutured the mucosa of this third is whipped over with catgut or silk. This sutured mucosa eventually becomes necrotic and sloughs off, but in the meantime it protects the tissues of the mesenteric stumps while healing occurs and until the formation of granulations which possess some immunity against infection. The continuous mattress suture is then brought through to the surface and continued as a right-angle suture with an occasional backstitch, turning in just enough margin of the bowel to produce accurate approximation. Unless an occasional backstitch is taken the suture may have the effect of a basting thread and when tied act as a purse-string suture



and produce occlusion. With the bowel cut somewhat obliquely and turning in a small amount of diaphragm the lumen of the bowel is but little affected. The diaphragm is more along the mesenteric border, because here the bowel is thicker than at the opposite border. When the point of beginning of the suture has been reached, the thread is tied to the original end several times and cut short, and usually the knot withdraws into the bowel. If necessary an interrupted mattress suture may be placed to bury the knot for further safety. The material used is linen or silk. Chromic catgut may be employed, and there is doubtless no essential difference, but as the thread is usually sloughed off into the bowel and passes in this way, and as peristalsis is often active, it seems preferable to use a non-absorbable suture. By this technic the lumen of the bowel at the union is accurately adjusted and adequately preserved by the sutures applied so as to turn in no more diaphragm than necessary.

When the lower small intestine or the colon is reached different biologic conditions confront us and must be met by changes in technic. Here, as has been said, peristalsis is slower and complete mechanical obstruction is not so rapidly fatal, chiefly because there would be less dehydration than would occur in the bowel higher up. One of the most important points, however, is the septic contents of the bowel. In the lower small intestines and in the colon the fæces literally teem with bacteria and the slightest soiling of the peritoneum may be fatal from peritonitis. In this region, too, a lateral anastomosis will be less disturbing to the physiology of peristalsis than it would be higher up. The problem, then, is not so much the establishment of a large lumen with a small diaphragm as it is the avoidance of infection even with a diminished lumen.

The principle evolved by Kerr and Parker is in surgery of the lower small intestines and the colon of the greatest aid. As elsewhere, the mesentery should be divided and tied, and everything should be completed up to the point of opening the bowel. Then the well-known technic of Kerr may be instituted. The bowel is doubly clamped at the points of proposed resection and divided with the electric cautery. The ends to be anastomosed are buried with a continuous basting suture, usually of fine silkworm gut. It is best to place the clamps so that when the bowel is brought together the mesenteries of the two resected ends will not be opposite each other. As the bowel is doubly clamped and opened with the cautery there is not the same necessity for occluding the triangular spaces as there would be if the bowel were opened with scissors or knife. The two blind ends are brought together and sutured with continuous or interrupted sutures of linen or silk. It is possibly safer to apply a first row of interrupted mattress sutures which would approximate the under surfaces and to insert all of the sutures before tying any of them. Then a continuous suture can be placed in addition, continued around anteriorly and tied to its original end. After this is done any weak points are reinforced with an additional mattress suture and the omentum can be brought over the sutured area and attached by a few stitches.

Finally the basting sutures are removed and the lumen of the bowel is established by invaginating the intestine above and below the anastomosis with the finger and thumb.

If the mesentery is fat it is difficult to safely approximate the bowel in an end-to-end manner. Here the basting suture is made firm, the bowel is puckered up over it and the two ends of the basting stitch are tied together and buried with a purse-string suture, or another row of continuous mattress sutures may be placed over the basting stitch; which of these methods is adopted will depend upon the mobility of the tissues. When the tissues are thick and fat is abundant, it will be probably better to use the continuous suture than the purse-string. Then the two ends of the bowel are laid side-by-side and the lateral anastomosis is made. Here, too, the technic of Kerr may be utilized by using a narrow clamp such as the Barr clamp, clamping the portion of the bowel where the stoma is to be and opening it with the cautery and burying it with a basting stitch. A similar procedure is carried out on both ends of the bowel. The lateral anastomosis is made and the basting stitches are withdrawn. However, if the bowel can be packed off and the ends stripped of fecal matter, frequently the stoma may be made by an open incision and the suturing done as in a gastro-enterostomy. While this involves somewhat the danger of contamination, the contamination is on the smooth peritoneal surface and with care can be reduced to a minimum and is much less dangerous than in the areolar tissue of the mesenteric border of the bowel. It certainly would seem safer, however, to use the technic of Kerr for making the opening in the lateral anastomosis.

The end-to-end anastomosis with a fat mesentery means that when the sutures are passed through the mesentery they must be so tight in order to secure approximation that necrosis of the fat may occur and leakage result. With the ends of the bowel well turned in this danger cannot occur and the stoma will involve merely the smooth peritoneal surface of the intestine. By the adoption of this technic the many-stage feature of resection of tumors of the colon can often be avoided. For additional safety a small enterostomy with a rubber tube may be made in the lower part of the ileum in order to relieve the pressure of gas and liquid fecal matter and to give the bowel rest during healing. If the anastomosis is on the left side the insertion of a rectal tube will often relieve the pressure of gas.

In resection of the lower sigmoid and rectum, which is usually done for cancer, the problem again takes on a somewhat different phase. For cancer of the rectum or lower sigmoid, I have abandoned any operation except the radical operation, making an artificial anus in the region of the left iliac fossa. I recall a case where the cancer was apparently small and movable and situated about two inches above the sphincter. I removed it with the electric cautery. Histologically it was not unusually malignant. The patient suffered considerable pain during the convalescence; finally the sphincter action was regained, but within a few months there was a rapid recurrence for which no radical operation could be done. On the other hand, I have had

## SOME UNDERLYING PRINCIPLES OF INTESTINAL SURGERY

two extensive cancers in which the prostate was involved and the dissection was made from the bladder with the electric cautery in the process of radical operation. One of these patients was recently operated upon, and the other was operated upon over three years ago. There have been no recurrences in them so far.

While by no means an apostle of standardization, I believe that unless a growth is located well up in the sigmoid where resection and union of the ends can be made, a cancer in the rectum and terminal sigmoid always demands radical extirpation and a permanent abdominal anus. In this method the general principles of a combined operation are followed. The abdominal operation is first made, exploring the liver and the lymph-nodes of the abdomen to ascertain if there are metastases and whether a radical operation is justifiable. After dividing the mesosigmoid and the inferior mesenteric artery, the peritoneum is incised around the bowel and the cul-de-sac. The dissection is done with the hand first in the hollow of the sacrum and then on either side so as to avoid the ureters. The bowel is divided according to the method of Kerr and both stumps are inverted. The upper stump is brought out through an incision in the left rectus muscle and fastened with some sutures to the peritoneal side and to the sheath of the rectus. The lower stump is pushed down into the pelvis and the peritoneum is completely sutured over the pelvis. The abdominal wound is closed. The patient is placed in the dorsal position and a median incision is made as though a prostatectomy were to be done and the bowel is separated anteriorly down to the prostate. The incision is then carried to the tip of the coccyx, the fascia is opened and the dissection with the hand meets the dissection above. The levator ani and the structures on either side are clamped and divided and the bowel is removed. If there are any adhesions of the cancer at the base of the bladder these adhesions are left for consideration last and are dissected away with the electric cautery, sometimes taking a portion of the prostate and the seminal vesicles. This entire procedure is somewhat long, and is more difficult if done in one stage than in two stages. However, it would seem that the inevitable infection and the presence of cancerous material having access to the lymphatics is the objectionable feature of the two-stage operation. The shock that follows by doing all of this in one stage is, of course, a decided objection, but it may be usually overcome by administering a five per cent. or ten per cent. solution of glucose in Ringer's solution in the vein, giving it continuously as soon as the abdominal operation has been begun. In this way the blood-pressure may be kept up and by having a donor matched up, a transfusion can be performed immediately after the perineal part of the operation has been completed. I would not undertake a radical operation for cancer of the rectum in one stage unless there was at least one donor matched for a transfusion to be given immediately after the operation.

The abdominal stump is left for three or four days without being opened. At the end of that time a soft rubber catheter is inserted and the gas permitted to escape. Usually this is satisfactory for a few days longer, so

that the artificial anus is not fully opened until a week after the operation. In this way infection is avoided and solid healing may be obtained.

These observations are the result of my experience, and the steps are based upon tragedies in my own practice which I might have avoided by taking the precautions that I have just mentioned. The turning in of too large a diaphragm in intestinal resection of the upper jejunum has resulted in a fatality in my own practice. The leakage of sutures when placed in fatty mesentery in an effort to do an end-to-end anastomosis in the lower ileum has also caused a fatality. The attempt to carry out extensive procedures without provision for preventing shock, as has already been mentioned, has resulted in death of the patient. By following these general principles the mortality from intestinal surgery, particularly surgery of the lower intestine, can, I believe, be greatly reduced.

## PROPHYLACTIC GASTROSTOMY\*

BY ERIC P. QUAIN, M.D.

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ONE of the distressing features following many abdominal operations, even after comparatively minor procedures, is the post-operative nausea and emesis. In most instances it is fortunately a mild and transient condition without serious consequences to the success of the surgical treatment. On other occasions the vomiting is protracted, and exhausting to the patient, and the pain produced in the wound may become intolerable without the administration of excessive amounts of opiates. After most of the radical operations in the upper abdomen, there is, as a rule, a temporary upset in the normal gastric and duodenal peristalsis. This causes a retention of contents in the stomach and often in the duodenum, and both may become distended with gases and liquids. Efforts to expel the abnormal contents by emesis are not always effective and repeated introductions of the stomach tube become unavoidable.

Anyone who has seriously considered the distress and pain produced by the passing of the stomach tube after a laparotomy, will agree that it is an abhorrent procedure from the viewpoint of the average patient. Many former patients, looking back over their sojourn in the hospital, have been heard to express the opinion that the stomach tube was the most disagreeable and painful part of their experience with the surgeon. The nauseating and choking sensation in the throat and the pain produced by the uncontrollable retching and pulling on the wound sutures combine to leave this unpleasant memory. Surgeons endowed with overly sympathetic temperaments have been known to avoid using the stomach tube, in response to the prayers and arguments of patients and friends, even when it was clearly indicated, and with harmful effects on the patients.

Safe and proper healing after any surgical operation depends for its success on perfect rest to that part of the body which has been incised and sutured. The required rest is hard to obtain when the operation has been made on a movable organ in the abdomen. Rest is hard to obtain, also, when the organ operated upon is subject to distention, deflation, and peristalsis, such as the case is with the stomach. Post-operative hemorrhage and leakage following gastric operations are invited and sometimes directly produced by a beginning gas distention and excessive pulling on the suture line.

It is for the purpose of calling attention to a prevention of some of these difficulties and complications, in suitable cases, that this article is prepared.

*Temporary gastrostomy in operations for perforated gastric and duodenal*

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\* Read before the Western Surgical Association, December 8, 1927.

ulcers is not a new form of treatment. Although no recent reference to the subject has been found in the literature, it nevertheless has been practiced and advocated in certain European clinics for the past twenty years or more.

Poissonier † in 1906 reported on its benefits in perforated gastric ulcer and mentioned two cases in which temporary gastrostomy alone seemed to have brought about cures of the ulcers. It was recommended by him particularly when the ulcer was located near the cardia. He termed it "gastrostomy of necessity" because it was applied originally in very desperate cases where no other surgery could be undertaken. He also referred to its prophylactic effect in regard to several complications following incisions and sutures in the stomach.

Lennander ‡ in 1908 stated the following indications for gastrostomy in a prophylactic sense:

1. In all cases of acute gastric dilatation where irrigation does not lead to its correction.
2. In cases of paralysis of the small intestine, and especially when the paralysis is high.
3. In operations for perforated ulcer of stomach or duodenum with pyloric or duodenal stenosis when gastro-jejunostomy is not possible.
4. In perforated ulcer operations when the ulcer cannot be closed, or where multiple ulcers are present.
5. In perforated ulcers where intestinal paralysis is likely to follow.
6. In cases where gastro-jejunostomy usually would be made but the patient's resistance contra-indicates its application.

Prophylactic gastrostomy has been a frequent procedure in a number of Swedish hospitals. While its main indication has been perforated gastric and duodenal ulcers, it has been used in other conditions also. Professor Key, of Stockholm, has performed it with good results in several cases of peritonitis from acute appendicitis.

Dr. T. Bratrud, of Warren, Minnesota, who first called my attention to this mode of treatment, recommends it from personal experience.

My first experience with the method was in one or two patients who were known to be intensely averse to the stomach tube, for reasons both mental and physical. They were cases in which at the time of operation, post-operative regurgitation was deemed inevitable. The encouraging results from this tentative application seemed to justify a wider use of the procedure, as the brief report following will indicate.

Very little has been stated about the technic of performing prophylactic gastrostomy. Professor Key places the tube through the anterior wall of the stomach some distance from the omental margin. It has seemed better to me to place it near the greater curvature. A fold of omental fat can then be fastened around the tube for two or three centimetres. This holds the

† Arch. Prov. de Chir., 1906, vol. xv, p. 421.

‡ Deut. Zeitsch. f. Chir., 1908, vol. xcii, p. 296.

stomach away from the abdominal wall and permits more freedom to gastric movements. A large falciform ligament has been utilized in some instances as additional protection between stomach and peritoneum.

A soft rubber tube, about the size of a No. 20 catheter, is placed into the stomach through a small stab wound near the omental margin 10 or 12 cm. from the pylorus. Two or more tannic catgut puckering sutures are inserted to infold the gastric wall. A rather deep infolding produces a valve action for prompt closing of the sinus when the tube later is removed. It should be kept *in situ* until it is entirely loose. Pulling on the tube while it is still attached to the gastric wall might evert the sinus and cause prolonged leakage. In our cases it has been removed from the ninth to the twelfth day. Normal gastric and duodenal peristalsis as a rule will be reëstablished after three or four days and the tube may be clamped permanently after its time of service is over.

The tube in the situation mentioned will be to the left of the linea alba. Although all our incisions in the epigastrium are made transversely, we have not placed the tube in the peritoneal wound, but passed it through a stab in the posterior aponeurosis a little to the left of the midline.

External fistulæ from the stomach, at least in the presence of fairly normal gastric secretion, do not cause the irritation to the wound and skin which often is so distressing in intestinal fistulæ. In some of our cases there was a slight seepage of gastric juice from the sinus after the tube loosened. In no such case was there any local reaction to the skin or to the patient's comfort. The seepage did not continue over four days in any case after the removal of the tube. The majority had no leakage whatever after the tube was out.

The immediate post-operative results to these patients have been very striking. There has been no epigastric distention and therefore much less pain requiring opiates. The patients have been permitted to drink water and, after the first hours, *ad libitum et ad desideratum*. This has been to their great satisfaction, and often entertainment, while watching and helping to control the outflow through the tube. Nausea has been present in some instances but to a less degree than in similar cases without gastrostomy. Emesis has rarely occurred; it has taken place only when the tube has been clamped too soon, or too long, and when it has been temporarily clogged. Because of the rapid and total escape through the tube of all the fluids swallowed, it is necessary to give large amounts of normal saline solution under the skin until peristalsis and absorption are reëstablished.

The greatest immediate boon to the patient has come through the non-use of the stomach tube. In several of our cases there was regurgitation of quantities of bile into the stomach. Formerly this signified much distress from retching and vomiting, and repeated seances with the stomach tube. With the gastrostomy tube *in situ* and unclamped, the swallowing of a few glasses of water would furnish a thorough gastric lavage and this procedure could

be repeated as often as desired, the patient often suggesting the proper time for washing the stomach.

Gastrostomy as a supplemental or prophylactic form of technic at the completion of other operations has been made in sixteen cases up to date. Three of the sixteen were operated upon for large, epigastric incisional herniæ following operations on the biliary tract through longitudinal incisions. It should be stated that all three had been operated upon originally by surgeons of modest attainments and moderate experience, which may account in part for the unfortunate breaking down of the wound and the wide separation of the aponeurotic margins.

CASE I had been operated upon for gall-stones a few years previously and had a protrusion in the scar, the size of two fists. A subphrenic abscess had followed the operation and this had been drained through a thoracotomy with resection of the eleventh rib. At the place of the thoracotomy was a second, thoracic, hernia within which a section of the right lung played in and out at each respiratory effort.

CASE II had suffered from protracted post-operative emesis after cholecystectomy. The wound had opened and attempts at secondary closure had been made. There was a wide hernial defect. The patient, a man of sixty-five years, also had intermittent attacks of intestinal obstruction with much pain and distention. It was found at operation that these attacks were caused by multiple, stenosing, intestinal adhesions. Several loops of the small intestine were incarcerated in the hernial sac. The unravelling and freeing of the intestine inflicted numerous traumatizations of the serosa and necessitated suturing of many denuded areas.

CASE III had a massive hernia in the epigastrium, with a thin covering of scar tissue. A cholecystostomy had been made about a year previously. A sinus discharging pus and occasionally bile was located in the midline near the umbilicus. At operation this sinus was found to lead into a pocket of granulation tissue, the wall of which was made up largely from a loop of jejunum. Another open sinus from the gall-bladder formed a connection with this abscess cavity. Cholecystectomy was made and two feet of the jejunum, comprising the infiltrated and infected abscess wall, were resected.

After completing the intra-abdominal work in these three cases, extensive dissection of the epigastric wall was made before sufficient overlapping of fasciæ could be obtained to give reasonable hopes for permanent cures of the herniæ. In spite of all effort it was evident in all three cases that the main holding sutures were under considerable tension, even when the patient was narcotized. Experienced surgeons will understand readily the possibilities for regurgitation and overdistention under these conditions. Some may even remember instances when the post-operative straining caused damage to the wound and detracted from the expected success of the herniotomy. Gastrostomy was made in each of these cases and there was neither distention nor emesis after the operation. The entire period of recovery was uneventful and final results very good.

CASE IV was an umbilical hernia of large size and long duration. After the incarcerated hernial contents, consisting of omentum, colon, and loops of small intestine, had been liberated, it was extremely difficult to replace them into the abdomen because of their volume and because of the decreased abdominal capacity. After finally succeeding in closing the hernia, gastrostomy was made and the post-operative troubles from distention were minimal.

CASES V and VI were operated upon for duodenal diverticula. The diverticulum in each case was located posteriorly and closely attached to the pancreas. Because of the difficult location, it was uncertain after removing the mucous membrane pouch, whether the opening had been closed properly, and fear was entertained that post-



operative paresis and overdistention might produce leakage and infection. Gastrostomy was made in each case and both the immediate reaction and the final results were gratifying.

CASE VII was operated for an acute perforation of a duodenal ulcer. The opening in the duodenum was closed and reinforced with an omental tag and gastrostomy made. The leakage before operation had started a progressive peritonitis which raised havoc in the lower abdomen and, together with a pneumonic process, caused the patient's death six days later. The absence of all distention in the epigastrium during the entire time after the operation, was a striking feature. The autopsy showed the stomach and duodenum collapsed and the omentum holding tightly over the perforation, with no evidence of infection in this region of the abdomen.

CASES VIII, IX and X were chronic perforating duodenal ulcers near the pylorus. Pylorectomy was made in two of these, while in the third gastro-enterostomy with pyloric exclusion was performed. Prophylactic gastrostomy was made in all three. The convalescence in each case was exceptionally smooth.

CASE XI had a fistula from the gall-bladder to the duodenum, requiring the excision of a rather large section of the duodenal wall in order to avoid placing the sutures in unhealthy tissue. The duodenal suture line seemed very feeble and gastrostomy was added as a precaution against possible overdistention. Recovery was easy and uneventful.

CASE XII had had a cholecystectomy at a previous operation and was suffering from recurring attacks of pain associated with fever and jaundice. He had almost constant nausea, and frequent emesis, and showed marked emaciation. At operation the pancreas was found enlarged, the common duct distended and oedematous, but without stones. A choledochoduodenostomy was made. Because of the icteric and sickly appearance of the sutured structures, much concern was felt in regard to prompt and safe healing, especially since regurgitation and emesis had become habituated with the patient. Prophylactic gastrostomy was therefore made. In this and two of the following cases, the end of the gastrostomy tube was passed through the pylorus into the duodenum, and a small lateral opening was cut in the tube where it rested within the stomach. Soon after operation bile began to flow freely from the gastrostomy tube and it continued to do so for several days. There was no distention, no retching, and no vomiting. Healing was symptom free; the jaundice cleared rapidly and the recovery seems to be permanent.

CASES XIII, XIV, XV, and XVI, in which gastrostomy was made, were in patients who had been operated upon for visceroptosis, periduodenitis, and duodenal obstruction. Duodeno-jejunoscopy was made in all four, and in addition some type of plastic fixation of ptosed viscera. In operations for visceroptosis, there is of necessity much handling and traumatizing of the abdominal viscera and temporary paresis, distention and regurgitation are to be expected during the first days after operation. The relief from distention, nausea, and emesis experienced by those operated upon and the greater assurance of physiologic rest and early healing of the visceral wounds have been outstanding features following gastrostomy in these four cases.

It is admitted that several of the patients on whom we made gastrostomy might have had just as good ultimate results if this technic had not been applied. But there were some on whom the multiple procedures undertaken would have been too hazardous for a one-stage operation without the use of the gastric safety valve under discussion. The comparatively much greater ease and comfort during the post-operative period have been such that the operation at no time has caused regrets, but always satisfaction. A conviction has grown that this additional surgery has not added to the operative risk, but that it has lessened it in each case. So far as it has been possible to

ascertain, no patient has had any symptoms to indicate late post-operative trouble from gastric adhesions at the place of gastrostomy.

From our limited experience we have been unable to formulate any statement as to possible contra-indications to this method, but we believe that its application has a wide field of usefulness in many types of abdominal operations.

If this technic should become as satisfactory to other surgeons as it has been to me, it would seem advisable to give it a distinctive name in order to differentiate the gastrostomy in this prophylactic sense from gastrostomies made for other reasons. For approval, the term *prophylactic gastrostomy*—or *gastrostomia prophylactica*—is herewith suggested.

## OBSERVATIONS ON PEPTIC ULCER\* (*Continued*)

### V. FINDINGS IN EXPERIMENTALLY PRODUCED PEPTIC ULCER: ETIOLOGIC AND THERAPEUTIC CONSIDERATIONS

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IN THE following experiments the formation of typical chronic peptic ulcers was induced in the stomach, duodenum and jejunum of dogs by several different procedures. Certain common factors, however, were present in all the procedures. After typical chronic ulcers had been produced, the factors which caused their formation were neutralized or removed and prompt healing of the ulcers ensued. In gross and microscopic characteristics, in the manner in which their formation was induced and in the manner in which their healing was accomplished, the experimentally produced ulcers were similar in many ways to peptic ulcers encountered in man. The ulcers in these experiments, therefore, will be discussed in their relation to the etiology and treatment of clinical cases of peptic ulcer.

In previous papers I have compiled bibliographies and reviewed the work of former investigators in this field. Only a few will be mentioned here for the purpose of calling attention to certain conceptions of peptic ulcer which have been generally accepted.

Bolton, Greggio, Ivy, Butsch, Durante, Rosenow and others have compiled bibliographies on the work of previous investigators, among the earliest of whom were Celsus, Bauhin, Lebert, Baille and Virchow. Cruveilhier, early in the nineteenth century, was one of the first to make a complete study of the morbid appearances, complications and sequelæ, clinical history, and rational treatment of the disease.

The economic importance of peptic ulcer is made apparent by a study of statistical data. Robertson and Hargis, from an analysis of 2000 necropsy protocols, found that ulcers or scars of ulcers occurred in 18.9 per cent. of cases. Of these 7.05 per cent. were gastric and 11.8 per cent. duodenal. In 7 per cent. of cases of ulcer both the stomach and duodenum were involved. The ratio of males to females affected was three to one.

Certain criteria have been generally accepted in distinguishing acute and chronic ulcers. An acute ulcer has a fresh appearance as if erosion had occurred rapidly and cleanly. The crater is usually cone-shaped with the apex in the base of the ulcer. Microscopically the acute ulcer is sharply defined and the surrounding tissues are healthy and normal. Evidences of

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Work done in the Division of Experimental Surgery and Pathology, The Mayo Foundation, Rochester, Minnesota.

epithelial proliferation are usually apparent at the margins. An acute ulcer, if undisturbed, heals rapidly and cleanly in a surprisingly short time.

A chronic ulcer, however, has a very different appearance. It has a sluggish looking punched-out crater which is usually cone-shaped but with the apex toward the mucosal surface. The edges overhang and the margins and base are dirty, necrotic and indurated. The surrounding mucosa usually shows a varying degree of chronic inflammation and is covered with mucus. Microscopically the chronic ulcer shows extensive inflammatory infiltration of the margins. The submucosa is wedge-shaped with the thick portion of the wedge toward the ulcer crater and the apex gradually merging into the normal submucosa some distance from the ulcer. The chronic ulcer usually shows evidence of extension rather than healing.

In between the extremes of acute and chronic ulcers are lesions exhibiting characteristics of both. They are subacute ulcers and probably represent the transition from an acute to a chronic lesion.

Acute ulcers occur not only spontaneously with certain diseases such as acute infections, fevers and toxæmias, but may be produced experimentally in many ways. Butsch, Greggio and Bolton have compiled bibliographies in this field and Greggio has divided the methods into several groups. These I have reviewed in a previous paper.

The means of producing chronic ulcers in experimental animals, however, are as few as those of making acute ulcers are numerous. Mann has gone so far as to say: "Chronic peptic ulcers appear to have never been consistently produced experimentally in the gastric mucosa by any method."

Acute ulcers which under normal conditions and in spite of most experimental conditions heal rapidly have in some cases been retarded in healing. A few investigators have produced lesions in the stomach or duodenum of experimental animals that are similar in some respects to the peptic ulcer found in the stomach and duodenum of man. Bolton, Friedman and Hamburger, Ivy, Turck, Greggio, Vedova and Durante, Bedarida, Dott and Lim, Exalto, Kehrer, Dragstedt and Vaughan, Rosenow, Hoffman and others have reported the production of such ulcers.

Probably the most successful method of producing peptic ulcers in experimental animals has been reported by Mann and Williamson. They shunted the alkaline bile and pancreatic juices and the alkaline secretion of the duodenum into the lower ileum where the alkali could not serve to neutralize the acid gastric juice. In their experiments ulcers were produced by this method in the duodenum and jejunum of dogs in more than 90 per cent. of cases. Such ulcers were grossly and microscopically almost indistinguishable from peptic ulcers found in the duodenum of man. In their experiments, however, no gastric ulcers were found.

Many investigators (Pavy, Ziemmsen, Leube, Cramer, Quincke and Daettwyler, Cohnheim, Griffini and Vassale, Matthas, Bolton, Ivy, Mann and others) have studied the healing process in experimentally produced ulcers. Mann has studied the healing of large numbers of ulcers produced by his

## OBSERVATIONS ON PEPTIC ULCER

method of surgical duodenal drainage and healed by gastrojejunostomy and pyloric exclusion which completely protected the ulcers from any exposure to acid chyme. He has observed that first there was a cleansing of the base of the ulcer. Slough separated and a protecting coat of serum and coagulum formed over healthy granulations, these processes taking usually about four days. Simultaneously the mucosa began to grow out from the edges as a thin layer of epithelial cells. The edges of the mucosa seemed to overhang and granulations pushed up in the centre so that the growing edge of mucosa was protected in the resulting depression. This initial stage, occupying about ten days, decreased the area to be healed. Once initiated the healing, if undisturbed, was rapid. In twenty days three-fourths or more of the base of a large ulcer was covered with epithelium and in thirty days the lesion was entirely healed. Often the scarring that remained was hardly noticeable. Recently Kennedy and Caylor, in clinical cases of duodenal and gastric ulcer respectively, have found healing lesions that were strikingly similar to healing experimental ulcers as described by Mann. As Bolton has suggested, any agent which retards the healing of an ulcer causes scarring, thickening and induration, giving the ulcer a punched-out appearance.

Many hypotheses regarding the etiology of peptic ulcer have been advanced, but their very multiplicity is proof of their inadequacy. Greggio has divided them into several groups according to their physiologic and pathologic basis and I have referred to them in a previous paper. Although certain theories may explain certain individual cases of ulcer they do not solve the real problem, the chronicity of peptic ulcer.

In the study of experimental ulcer two facts seemed to stand out: First, all acute lesions produced in the normal stomach healed very rapidly and readily and, second, the method of surgical duodenal drainage described by Mann and Williamson induced the formation of ulcers in the duodenum and jejunum of dogs in more than 90 per cent. of experiments. I then conceived the idea of making acute lesions in the stomach of dogs and at the same time performing the operation for surgical duodenal drainage in order to determine whether the stomach would still heal with its usual rapidity and completeness. In later experiments I also carried out other procedures, some of them in conjunction with surgical duodenal drainage, in order to study various other phases of the production and healing of peptic ulcer.

*Methods of Experimentation.*—Normal healthy dogs were used in all experiments, and for all operative procedures ether anæsthesia and aseptic technic were employed. No rubber-covered or other intestinal clamps and no unabsorbable sutures were used in any of the operations, all of which were performed by me. In the experiments the more important of these operative procedures were carried out either singly or in various combinations.

Acute lesions were made in the stomach by excising certain areas of the gastric mucosa through an incision in the anterior wall of the stomach. Selected areas of mucosa were lifted with Allis forceps and excised with sharp scissors so that four circular areas of gastric wall, about 2 cm. in

diameter, were left denuded of mucosa. Hemorrhage was sometimes profuse for a few moments but always stopped spontaneously. In no case was any suture or ligature applied to vessels in these areas and no case of secondary hemorrhage was encountered.

The operation for establishing surgical duodenal drainage was performed as follows: The pylorus was severed, the distal cut end closed, the first portion of jejunum was severed and the proximal cut end closed. The proximal cut end of pylorus was joined to the distal cut end of jejunum by end-to-end anastomosis, the continuity of the gastro-intestinal tract being thereby reestablished. The closed segment of intestine consisting of the duodenum and a small part of the first portion of the jejunum was drained into the ileum by side-to-side anastomosis at a point about 25 cm. proximal to the cæcum.

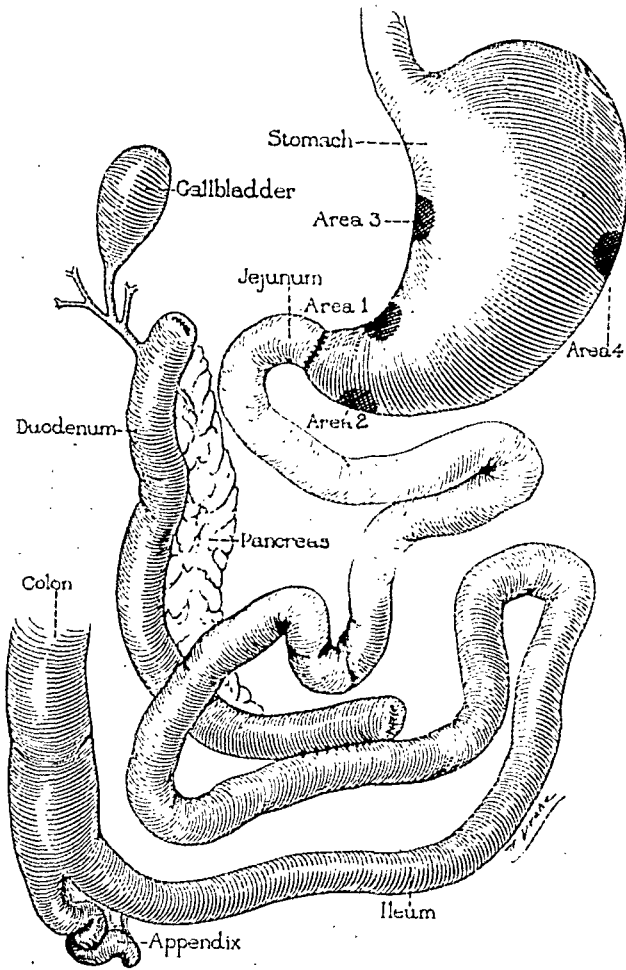


FIG. 1.—Diagram of operation for surgical duodenal drainage. Shaded areas in stomach denote those denuded of mucosa in Groups I, 3 and 4.

was obtained by resecting a loop of jejunum about 5 cm. in length. Care was taken not to injure the mesenteric vessels of the resected loop which was split longitudinally opposite its mesenteric attachment and trimmed to a circular shape about 5 cm. in diameter. The patch was then sutured into the gastric wall so as to lie flat and replace a resected portion of gastric wall of the same size and shape. The continuity of the gastro-intestinal tract was reestablished by end-to-end anastomosis of the ends of intestine from which the patch was obtained. No more than one patch was transplanted in a single stomach.

The röntgenologic examinations made in some experiments were carried

Patches of jejunum of whole thickness and with intact mesenteric circulation were transplanted into various sites in the wall of the stomach in the following manner: Each patch

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out under essentially the same conditions that obtain in similar examinations of the gastro-intestinal tract in man. After a fasting period of from twelve to twenty-four hours, opaque meals consisting of equal parts by weight of barium sulphate powder, gum acacia solution of syrupy consistency and condensed milk were administered to the dogs in the proportion of 15 gm. of the mixture for each kilogram of body weight. Immediately after the ingestion of the meal, and at intervals of two, five and seven hours, fluoroscopic examinations and röntgenograms were made.

Gastro-enterostomy in these experiments was performed anteriorly, about 5 cm. proximal to the pylorus and in the isoperistaltic direction. Experience with dogs has shown that this method gives the best results functionally.

*Results.*—GROUP 1.—*Excision of Areas of Mucosa Alone and Areas of Mucosa and Muscularis in the Normal Stomach and Duodenum.*—There were eight experiments in this group. Denuded areas were made in the duodenum just distal to the pylorus and in four sites in the stomach (Fig. 1). All areas were about 2 cm. in diameter.



FIG. 2.—Growing edge of mucosa in healing area in a stomach in Group 1. Four days after operation (x 150).

In the stomach areas 1 and 2 were on the lesser and greater curvatures, respectively, about 3 cm. from the pylorus, and areas 3 and 4 were midway along the lesser and greater curvatures, respectively. Denuded areas were examined at various intervals from eight to fifteen days after they were made, either after the animal had been killed under anaesthesia or after the portion of the tract containing the denuded areas had been resected.

In all cases the denuded areas healed rapidly and cleanly. From the relative sizes of the lesions in the stomach at various intervals it appeared that areas on the lesser curvature healed a trifle more slowly than those on the greater curvature. Healing in the pyloric region was a little slower than in the fundus. All areas, however, healed so rapidly that in two weeks epithelium covered the entire area denuded of mucosa at operation. Scars were small and often hard to find. There was no appreciable difference in healing in areas from which mucosa alone or both mucosa and muscularis had been denuded. By microscopic study of the specimens, healing was found entirely similar to that described by Mann and others and previously mentioned (Fig. 2).

GROUP 2.—*Surgical Duodenal Drainage.*—There were twenty consecutive experiments in this group. In each case the duodenum with intact circulation and bile duct and pancreatic ducts attached was resected, closed at both ends

and anastomosed so as to drain all the alkali of the bile, pancreatic juices, and its own secretion into the ileum. The jejunum was attached to the stomach so that anatomically it replaced the duodenum. The alkali was drained into the ileum so far distal to the pylorus that the possibility of regurgitation of alkali, as far as the stomach or jejunum into which it emptied was precluded (Fig. 1). Digestive processes, however, continued and apparently were not hindered by the altered anatomic conditions. This was proved by the fact that dogs usually remained in good condition after operation. A

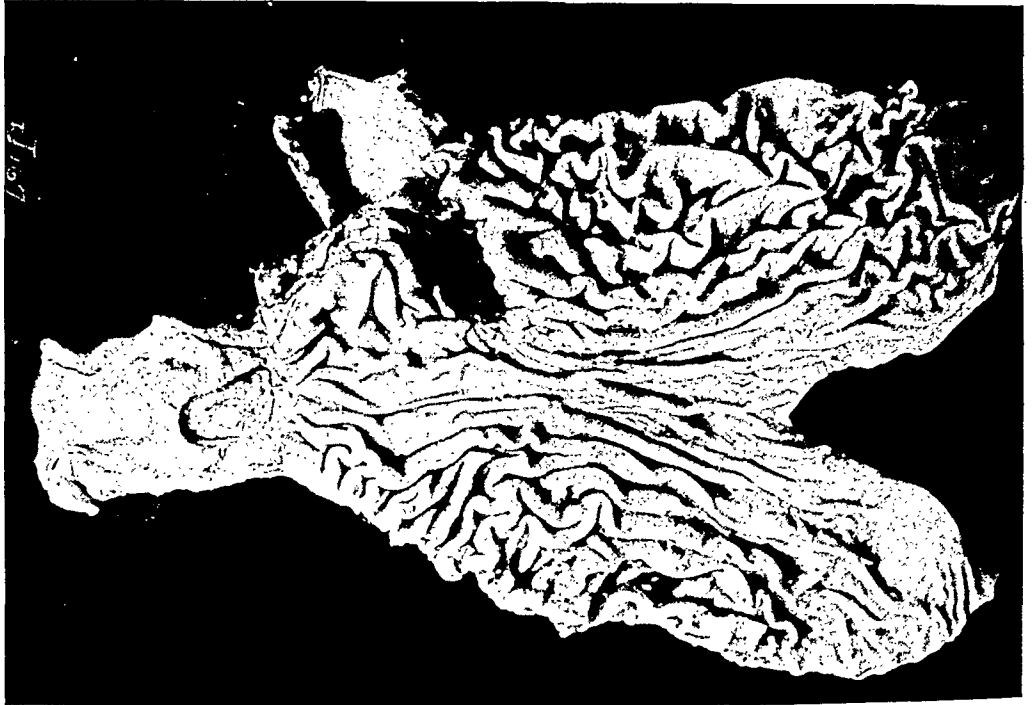


FIG. 3.—Typical chronic ulcer in jejunum induced by surgical duodenal drainage in Group 2. Thirty-one days after operation.

mixture of milk and corn syrup added to their regular diet was the only way in which their care differed from that of normal dogs. No nutritional disturbance occurred until the ulcer, developing at the usual site in the jejunum following surgical duodenal drainage, attained a considerable degree of chronicity. Loss of weight when it occurred seemed to be attributable to the ulcer rather than the cause of it.

In all of the experiments typical subacute and chronic ulcers developed in the jejunum at the usual site. They were found in the jejunum from 0.5 to 2 cm. distal to the line of anastomosis with the stomach and at the point where the acid chyme emptying from the stomach impinged directly against the wall of the intestine. Bleeding and perforation frequently occurred with these ulcers. The earliest ulcer in the group was found fourteen days after operation. The last dog in the group died from peritonitis from perforation of a typical ulcer four months after operation. All the ulcers found in this group were characteristically subacute and chronic and were grossly and microscopically almost indistinguishable from peptic ulcers found in the



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duodenum of man (Fig. 3). Gastric ulcers were never found in these or any other experiments in which surgical duodenal drainage alone was instituted.

GROUP 3.—*Four Areas in the Stomach Denuded of Mucosa and Surgical Duodenal Drainage Established at the Same Operation.*—In twenty-eight experiments areas were denuded in the stomach as in Group 1. At the same laparotomy surgical duodenal drainage was established in the same way as in Group 2 (Fig. 1). Eight experiments were discarded because of post-

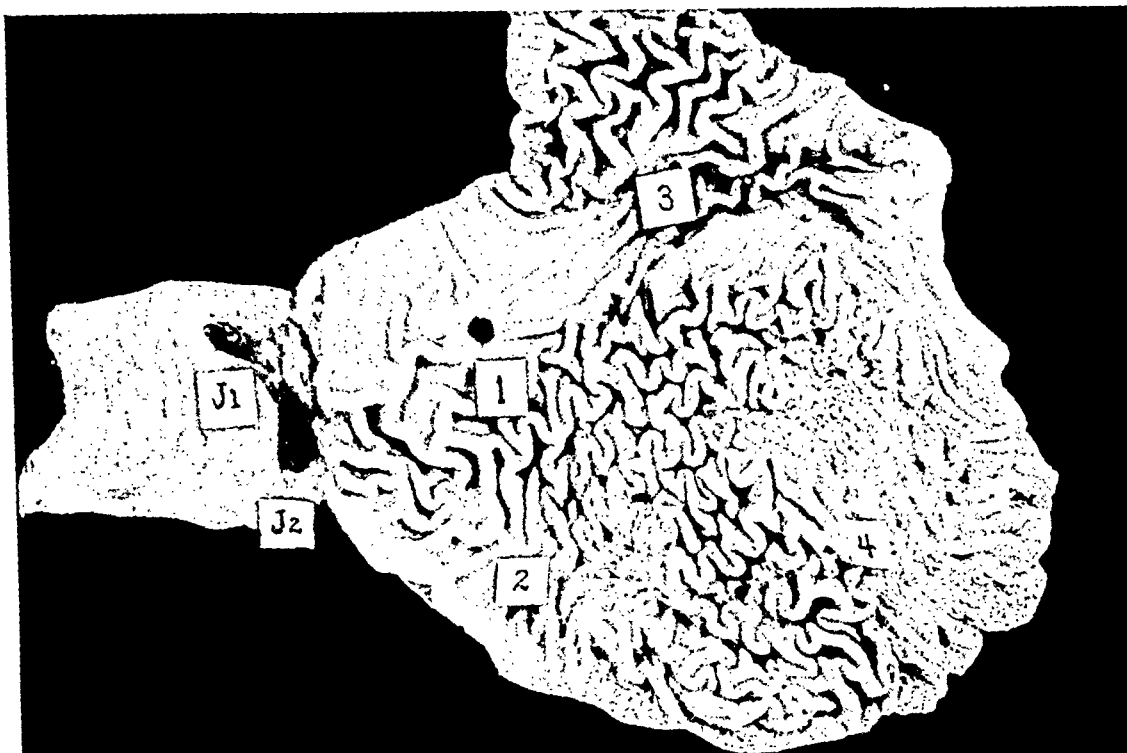


FIG. 4.—Typical chronic ulcer in stomach at area 1, induced by the procedures of the third and fourth groups. Small ulcer at area 3. Lesions at areas 2 and 4 entirely healed. Thirty days after second operation (Group 4).

mortem changes and other extraneous circumstances which marred some of the specimens. Data in the twenty remaining experiments were complete and satisfactory. The shortest experiment lasted four days and the longest ninety-five days. In every experiment there was marked delay in healing of denuded areas in the stomach. Excluding two experiments of less than a week's duration, there were eighteen which lasted for long periods. In 50 per cent. of these, healing was not only very much delayed but definite ulcers formed in areas 1 and 3 on the lesser curvature of the stomach. These were grossly and microscopically typical subacute and chronic peptic ulcers (Fig. 4).

Delay in healing was much more marked on the lesser curvature than on the greater. Frequently in the same stomach typical chronic ulcers were found in areas 1 and 3 on the lesser curvature while healing or completely healed scars were found in areas 2 and 4 on the greater curvature (Fig. 5). Healing in area 2 in the pyloric region of the greater curvature was not so rapid as that in area 4 in the middle region of the greater curvature which

healed more rapidly than any other site in the stomach. In two experiments small ulcers were found in area 2 in addition to large ulcers in areas 1 and 3 on the lesser curvature. Except for these two associated ulcers, all ulcers found in the experiments occurred on the lesser curvature of the stomach.

All gastric ulcers were typically subacute and chronic. One of them perforated and caused the animal's death from peritonitis. Others had perforated all coats of the gastric wall and were prevented from communi-

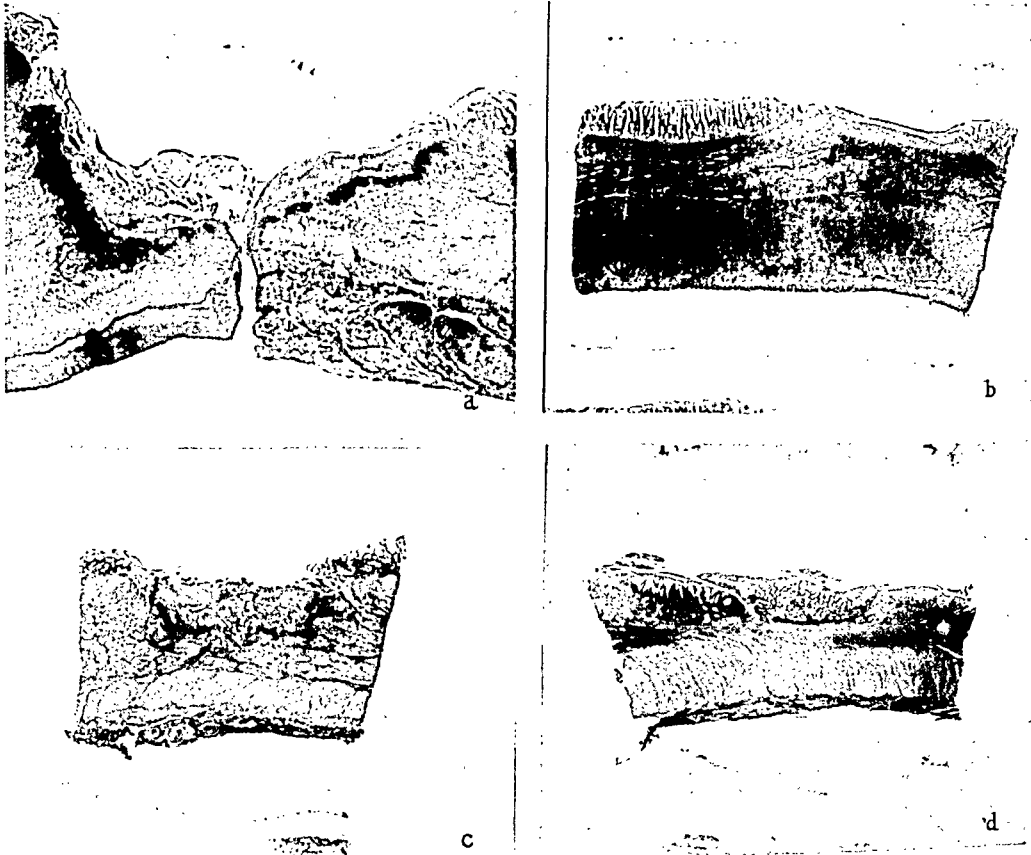


FIG. 5.—Typical sections of four areas in a stomach (Group 3) twenty-six days after surgical duodenal drainage (x8). a. Area 1, ulcer that perforated. b. Area 2, healing. c. Area 3, small ulcer. d. Area 4, healed.

cating with the general peritoneal cavity only by adhesions with the omentum or other tissues. The oldest of the gastric ulcers was one found thirty-five days after operation. The dog died from peritonitis from perforation of the jejunal ulcer at the usual site. Besides the lesions described in the stomach, ulcer formed in practically all animals at the usual site in the jejunum following surgical duodenal drainage; the frequent perforation of such ulcers was the reason that more experiments of long duration were not available in the group.

GROUP 4.—*Surgical Duodenal Drainage Established and Four Areas in the Stomach Denuded of Mucosa Two Weeks Later.*—The experiments in this group were essentially the same as those in Group 3, except that areas in the stomach were not denuded of mucosa until two weeks after the estab-

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lishment of surgical duodenal drainage. This interval between the two operations was tried because it had been found that ulcers in the jejunum following surgical duodenal drainage rarely formed earlier than two weeks. On the assumption that the same factors both induced the formation of ulcer in the jejunum and delayed the healing of areas in the stomach with subsequent formation of ulcers on the lesser curvature, it was hoped by the interval between operations to subject denuded areas in the stomach to the hypothetical factors at a time when they had been found to induce ulceration in the jejunum in almost 100 per cent. of experiments.

There were twenty consecutive experiments in all of which the data were complete and satisfactory. The earliest observation on the stomach was two

Table 1  
Series of jejunal patches

Dog	Patch placed in stomach, date of operation	Situation of patch in stomach	Patch explored, date of operation	Condition of patch	Time interval, days
1	1-30-25	Lesser curvature near pylorus	3-25-26	Normal	419
2	7- 9-25	Lesser curvature near pylorus	2- 1-26	Normal	175
3	7-27-25	Lesser curvature near pylorus	2- 1-26	Normal	157
4	7-27-25	Lesser curvature near pylorus	2- 1-26	Normal	157
5	7-28-26	Lesser curvature near pylorus	1- 7-26 (Death, cause ?)	Ulcer on patch 1.5 by 1 cm.	163
6	7-28-26	Lesser curvature near pylorus	9- 2-25 (Death, cause ?)	Normal	36
7	7-29-26	Lesser curvature near pylorus	2- 4-26	Normal	190
8	8- 7-25	Lesser curvature near pylorus	2- 4-26	Normal	181
9	9- 7-25	Lesser curvature near pylorus	1-20-26	Normal	135
10	9- 7-25	Lesser curvature near pylorus	1-22-26	Normal	137
11	9- 7-25	Lesser curvature near pylorus	1-25-26	Normal	140
12	9- 9-25	Lesser curvature near pylorus	1-25-26	Normal	138
13	9- 9-25	Lesser curvature near pylorus	1-20-26	Normal	133
14	3- 9-26	Anterior wall near pylorus	6- 7-26	Normal	90
15	3-10-26	Anterior wall near pylorus	6- 7-26	Normal	89
16	3-10-26	Middle of anterior wall	6- 7-26	Normal	89
17	3-11-26	Middle of posterior wall	6-10-26	Normal	91
18	3-18-26	Middle of posterior wall	6-10-26	Normal	84
19	3-23-26	Middle of greater curvature	7- 1-26	Normal	100
20	3-23-26	Anterior fundus region	6-11-26	Normal	80
21	3-23-26	Anterior fundus region	6-11-26	Normal	80

days after operation and the latest ninety days. In every experiment the areas in the stomach denuded of mucosa and situated in the usual four sites showed delay in healing. Delay in healing was much more marked in areas 1 and 3 on the lesser curvature than in areas 2 and 4 on the greater curvature. Excluding four experiments of less than a week's duration, there were sixteen which lasted for long periods. In 62.5 per cent. of these, not only was healing much delayed but definite ulcers formed in areas 1 and 3 on the lesser curvature of the stomach. These were grossly and microscopically typical subacute and chronic peptic ulcers similar to those in Group 3 and almost indistinguishable from peptic ulcers of the stomach encountered in man (Fig. 4). All the ulcers in this group were found on the lesser curvature of the stomach, the oldest of them having been found two months after operation.

GROUP 5.—*Patch-transplants of Jejunum in the Normal Stomach for Long Periods.*—Patches of jejunum of whole thickness and with intact

mesenteric circulation were transplanted into several different sites in the gastric wall of twenty-one dogs (Table I). Patches in the anterior and posterior walls and in the lesser and greater curvatures were observed for long periods varying from thirty-six to four hundred and nineteen days. In all experiments except one, all patches remained normal. In this experiment a patch transplanted into the lesser curvature of the stomach ulcerated superficially one hundred and sixty-three days after the patch had been transplanted.

GROUP 6.—*Patch-transplants of Jejunum Following Surgical Duodenal Drainage.*—In thirteen dogs from the preceding group patches of jejunum which had remained normal for long periods, from eighty to four hundred nineteen days, were studied following surgical duodenal drainage (Table II).

Table 2  
Series of jejunal patches after duodenal drainage

Dog.	Jejunal patch		Duodenal drainage, date of operation, 1926	Date of necropsy 1926	Condition of patch	Time interval, days	Ulcer in jejunum
	Situation in stomach	Duration, days					
1	Lesser curvature near pylorus	419	3-25	6-22	Normal	89	No
2	Lesser curvature near pylorus	175	2-1	4-19	Ulcer 2 by 1.5 cm.	77	No
3	Lesser curvature near pylorus	157	2-1	3-3	Ulcer 2 by 1.5 cm.	30	Yes, 1 by 1 cm.
4	Lesser curvature near pylorus	157	2-1	3-12	Two ulcers, one perforated	39	Yes, 2 by 1 cm.
5	Lesser curvature near pylorus	190	2-4	3-5	Normal	29	Yes, 1.5 by 1.5 cm.
6	Anterior wall near pylorus	90	6-7	7-5	Normal	28	No
7	Anterior wall near pylorus	89	6-7	7-30	Normal	47	Perforating ulcer 1 cm.
8	Middle of anterior wall	89	6-7	7-5	Normal	28	Perforating ulcer, 3 by 2 cm.
9	Middle of posterior wall	91	6-10	7-30	Normal	50	Yes, 1 by 1.5 cm.
10	Middle of posterior wall	84	6-10	7-30	Normal	50	Yes, 3 by 3 mm.
11	Middle of greater curvature	100	7-1	7-30	Normal	29	Yes, 8 by 8 mm.
12	Anterior fundus region	80	6-11	6-18	Normal	7	No
13	Anterior fundus region	80	6-11	6-29	Superficial erosion	18	Yes, 2.5 by 2 cm.

That patches were normal was determined by direct inspection at the laparotomy at which surgical duodenal drainage was established. Patches in various situations in the stomach were studied at intervals from seven to eighty-nine days following surgical duodenal drainage. Except for a superficial erosion in a patch on the anterior wall in one experiment, ulcers were found only in patches situated in the lesser curvature. Typical chronic peptic ulcers developed in three of five experiments in which patches had been transplanted into the lesser curvature of the stomach (Fig. 6). Surgical duodenal drainage induced formation of ulcer in patches of jejunum on the lesser curvature; patches in other situations in the stomach remained normal.

GROUP 7.—*Röntgenologic Examinations of Ulcer of the Jejunum Induced by Surgical Duodenal Drainage.*—Twelve normal dogs, on several different occasions, were given opaque barium meals for fluoroscopic examination and röntgenograms of their gastro-intestinal tracts. Röntgenologic findings were very constant in all cases and demonstrated that the gastro-intestinal tract of

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the dog could be examined röntgenologically with considerable ease and precision. The shape of the dog's stomach was found slightly different from that of man, but in other respects the stomach and duodenum conformed very closely to their röntgenographic appearance in man.

Of the twelve animals studied as normal controls, six were studied röntgenologically at weekly intervals for ulceration following surgical duodenal drainage (Table III). In every one of the animals an ulcer appeared at the usual site of ulceration in the jejunum following surgical duodenal drainage (Fig. 7). Of the six ulcers three were typically chronic in type and

Table 3 Summary of protocols of six animals examined for ulcer formation

Dog	Date of operation	Number of examinations after operation	Roentgenologic examination		Exploratory laparotomy		Date of death	Necropsy findings	Remarks
			Date	Findings	Date	Findings			
H 812	4-8-25	7	5-7-25	Suspicious of ulcer.			7-13-25	Large, typical chronic ulcer that had caused death by perforation.	Typical chronic ulcer diagnosed by roentgen ray and verified at necropsy.
			5-13-25	Definite ulcer.					
I 24	4-23-25	7	5-27-25	Suspicious of ulcer.			5-15-25	Subacute ulcer that had caused death by perforation.	Subacute ulcer suspected by roentgen ray and verified at necropsy.
			6-7-25	More suspicious.					
I 25	4-23-25	2	5-29-25	Stomach tremendously dilated; ulcer surmised.			5-12-25	Subacute ulcer that had caused death by perforation.	Subacute ulcer suspected by roentgen ray and verified at necropsy.
J 39	4-26-26	5			5-17-26	No ulcer present and entire gastro-intestinal tract apparently normal.	7-1-26	Ulcer that had perforated in the acute developing stage and caused death.	Acute ulcer. Roentgen ray and exploratory laparotomy failed to find the ulcer which no doubt developed only a few days before death.
J 118	4-26-26	9	5-26-26	Definite ulcer.	6-3-26	Large chronic ulcer.	7-2-26	Perforating acute ulcer opposite the gastro-enterostoma. Original ulcer diagnosed by roentgen-ray had healed considerably.	Typical chronic ulcer diagnosed by roentgen-ray and verified by exploration. Partially healed as seen in roentgen ray, verified by necropsy.
			5-2-26	Ulcer grown larger.	6-17-26	Ulcer grown larger (gastro-enterostomy performed).			
			6-28-26	Ulcer smaller and less distinct.					
J 167	5-4-26	3	5-26-26	Definite ulcer.	6-3-26	Large chronic ulcer that had apparently perforated within 2 or 3 hours preceding exploration. Gastro-enterostomy performed in the hope of saving animal. Perforation closed.	5-4-26	Considerable peritonitis as found at exploration. Large perforating ulcer as repaired at exploration.	Typical chronic ulcer diagnosed by roentgen-ray and verified by exploration and necropsy.

each of them was diagnosed by Röntgen-ray. Two others were of the subacute type and although suspected at fluoroscopic examination, were not depicted with certainty in the röntgenograms. One was an acute ulcer that apparently formed after the last röntgenologic examination and just before the animal's death. It has been found in a few experiments in a large series that the usual chronic ulcer does not appear after surgical duodenal drainage, but instead an acute ulcer forms very rapidly and perforates within a few hours from the time of its first appearance.

In one animal in which a large, crater-shaped, indurated ulcer was demonstrated röntgenologically and at exploration, the stomach was anastomosed to a loop of jejunum about 50 cm. distal to that containing the ulcer. A large stoma was made in order that the greater part of the gastric contents might empty through it. Following this operation the large ulcer just distal to the pylorus became much smaller and more difficult to depict röntgenologically. At necropsy, fifteen days later, this ulcer had lost its induration and deep, crater-like shape, and had healed considerably.

Until the actual formation of ulcer there was no appreciable difference in the röntgenologic characteristics of the gastro-intestinal tract of the dogs before and after surgical duodenal drainage. Contractions of the stomach seemed entirely unchanged both in rhythm and character. After ulcer had formed there was sometimes a slight tendency toward stasis which seemed to be the result of the ulcer. In one experiment stasis of a considerable degree followed the formation of ulcer.

GROUP 8.—*Healing of Chronic Ulcers After Gastro-enterostomy.*—The operation for surgical duodenal drainage was performed in nine healthy, nor-



FIG. 6.—Stomach with jejunal patch in lesser curvature. Chronic ulcer in patch and chronic ulcer at usual site in jejunum thirty days after surgical duodenal drainage (Group 6).

mal dogs. Exploratory laparotomy was performed at various intervals from twenty to sixty-five days afterwards. A typical subacute or chronic peptic ulcer was found at the usual site in the jejunum of every dog. At the same laparotomy gastro-enteric anastomosis was made. In each experiment a loop of jejunum about 20 to 40 cm. distal to that containing the ulcer was anastomosed to the stomach anteriorly and in the isoperistaltic direction. The stoma was made large enough for the greater part of the gastric contents to empty through it (Table IV).

At various intervals, from four to sixteen days, after gastro-enterostomy necropsy was performed. In every case the ulcer showed unmistakable signs of healing. In two experiments small but typical subacute ulcers had healed entirely in ten and fifteen days, respectively, after gastro-enterostomy. In

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another experiment a typical, indurated, chronic ulcer measuring at exploration 1 cm. in diameter and 0.5 cm. in depth had healed almost completely in sixteen days (Fig. 8). The rate of healing of the ulcers after gastro-enterostomy was in direct proportion to the size and chronicity of the ulcer and the duration of the gastro-enteric anastomosis. Microscopically the healing was very similar to that previously described by Mann and alluded to in this paper, although it was not as rapid and clean and orderly as the healing he induced by gastro-enterostomy and pyloric exclusion which completely protected the ulcer from contact with acid chyme (Figs. 9 and 10). Besides the healing ulcers found at necropsy new, developing ulcers were usually found in the efferent loop of jejunum just opposite the gastro-enteric

Table 4 Synopsis of the protocols of the nine experiments with healing ulcer

Ex- perim- ent	Surgical duodenal drainage Date, 1926	Exploration and gastro-enterostomy		Necropsy	
		Date, 1926	Inter- val, days	Date, 1926	Inter- val, days
1	4-26	6-3	38	7-2	15
		6-17	52		
		Findings and remarks			
		Chronic ulcer 1 cm. in diameter. (No gastro-enterostomy) Chronic ulcer 2 by 1.5 cm. 1 cm. in depth			
2	6-25	7-15	20	7-30	15
				7-24	9
		Two subacute ulcers, each 0.5 cm. in diameter and about 0.4 cm. in depth			
3	6-25	7-15	20		
		Two subacute ulcers, one 0.3 cm. in diameter and 0.3 cm. in depth, the other 0.6 cm. in diameter and 0.2 cm. in depth			
4	7-5	9-8	65	9-18	10
				9-15	7
		Chronic ulcer 1 cm. in diameter and 0.5 cm. in depth			
5	7-19	9-8	51	9-19	10
				9-25	16
		Subacute ulcer 1.5 cm. in diameter and 0.2 cm. in depth			
6	7-19	9-9	52	9-14	4
				9-20	7
		Chronic ulcer 1.5 cm. in diameter and 0.7 cm. in depth			
7	7-19	9-9	52		
		Chronic ulcer 1 cm. in diameter and 0.5 cm. in depth			
8	7-22	9-10	50		
		Chronic ulcer 1.5 cm. in diameter and 0.5 cm. in depth			
9	7-29	9-13	46		
		Chronic ulcer 1.5 cm. in diameter and 0.7 cm. in depth			

stoma. These ulcers were found always at the point in the efferent loop against which the acid chyme emptying from the stomach impinged most directly.

GROUP 9.—*Ulcers in the Duodenum Following Gastric Resection.*

*Procedures.*—In a small

GROUP 9.—*Ulcers in the Duodenum Following Certain Miscellaneous Procedures.*—In a small number of dogs surgical duodenal drainage was established by a slightly modified technic. Instead of the jejunum being anastomosed end-to-end with the pylorus, the pyloric third of the stomach was resected and the jejunum was anastomosed to the stump of the stomach by the method of Billroth in some cases and by the method of Polya in others. The area of the stomach was thereby decreased and the amount of acid secreted thus probably diminished. The duodenum was anastomosed to the ileum as usual. Even following such modified forms of surgical duodenal drainage, ulcers were usually found in the jejunum at the point where the acid chyme emptying from the stomach impinged directly against

the wall of the intestine. The ulcers, however, were not so typically chronic as those following the ordinary type of surgical duodenal drainage and were oftener subacute or acute.

In a rather high percentage of dogs following ligation of the common bile duct, ulcers were found in the duodenum just distal to the pylorus where the emptying acid chyme from the stomach impinged against the wall of the intestine. The ulcers found in such experiments were oftener subacute than chronic, although occasionally deep indurated lesions were found. Ligation

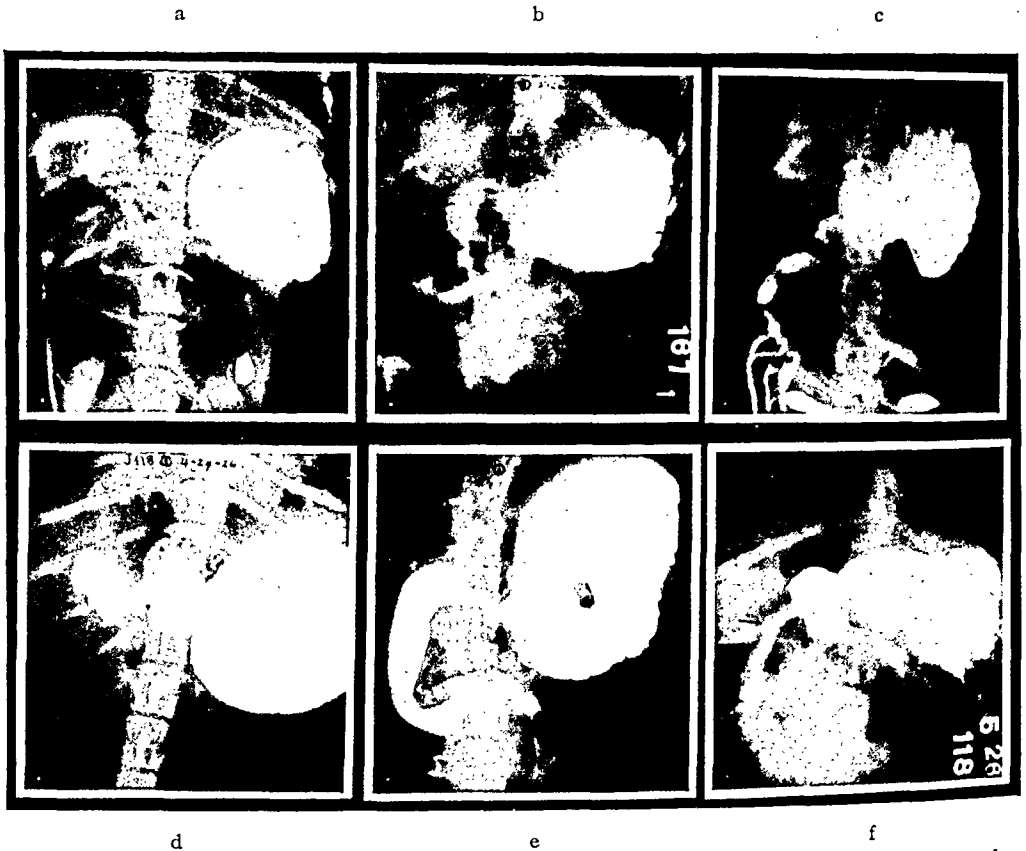


FIG. 7.—Ulcers of the jejunum following surgical duodenal drainage in Group 7. a. Normal before operation. b. Ulcer crater. c. Larger ulcer crater. In another experiment: d. Normal before operation. e. Normal after operation. f. Ulcer crater found at later examination.

of the common duct of course induced deep jaundice, but ligation also excluded bile from the duodenum and other parts of the gastro-intestinal tract.

GROUP 10.—*Miscellaneous Methods by Which Healing of Peptic Ulcers Was Induced.*—A few experiments were performed similar to those of Mann, who induced healing of ulcers following surgical duodenal drainage by gastro-enterostomy and pyloric exclusion. Ulcers were thereby entirely protected from acid chyme and healed quite rapidly as described by Mann. Ulcers developed in the efferent loops of the gastro-enteric anastomoses just as they had in previous experiments. They formed more rapidly in this group than in Group 8 in which the pylorus was not excluded.

In a few experiments typical chronic ulcers at the usual site following surgical duodenal drainage were healed by duodenojejunostomy. The anas-



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tomosis was made between the closed upper part of the duodenum and the jejunum, and the stoma was situated opposite the ulcer. Alkali was thereby drained into the jejunum at the site of the ulcer. In all these experiments the ulcer showed definite characteristics of healing.

Healing was induced in a few typical chronic ulcers by gastroduodenostomy. The closed upper part of the duodenum was anastomosed to the pyloric region of the stomach (Fig. 11). By this method also alkali was presumably drained into the stomach. Moreover, drainage of some of the

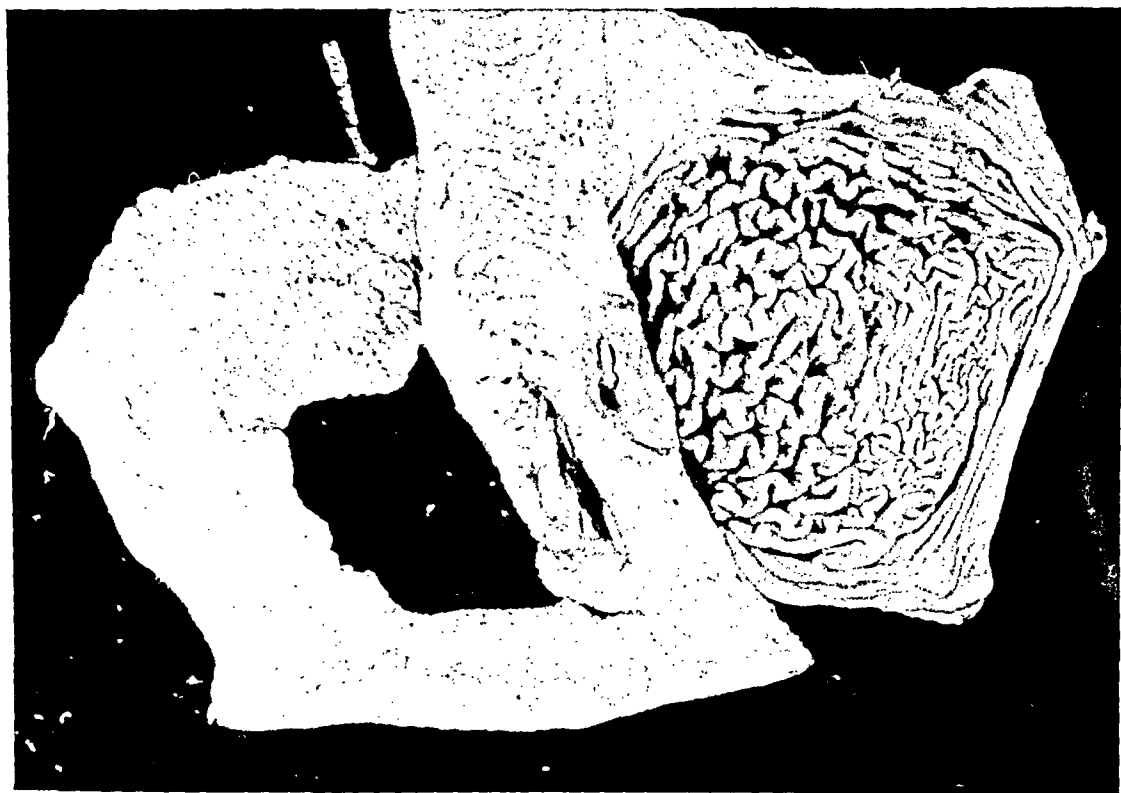


FIG. 8.—Healing ulcer sixteen days after gastro-enterostomy and new ulcer developing in the efferent loop (Group 8).

acid chyme from the stomach probably took place through the duodenum and thence into the ileum. Healing that followed this procedure was quite rapid and satisfactory.

*Discussion.*—Acute lesions in the normal stomach and duodenum of experimental animals and man usually heal with great rapidity and completeness. This was verified by the experiments in the first group; areas in the stomach and duodenum were denuded of mucosa, and in some cases of both mucosa and muscularis, and yet they healed in two weeks. Healing on the lesser curvature, however, was a trifle slower than that in other parts of the stomach.

The results of the experiments in the second group were striking in that peptic ulcers developed in the jejunum in 100 per cent. of experiments following surgical duodenal drainage. The ulcers were typical subacute and chronic lesions and were grossly and microscopically almost indistinguishable from peptic ulcers found in the duodenum of man. They occurred just distal

to the pylorus at the point where the acid chyme emptying from the stomach impinged directly against the wall of the intestine. This site corresponds to that at which duodenal ulcers are found in man. They occurred in the jejunum which had been so transplanted that anatomically it took the place of the duodenum. All the alkaline duodenal secretion and alkaline bile and pancreatic juices normally present in the duodenum at the pylorus and regurgitating into the stomach had been drained into the ileum at such a distance that their regurgitation as far as the stomach (or intestine into which it emptied) was precluded. The stomach ejected its acid through its nozzle-like



FIG. 9.—a. Typical eroding margin of a chronic ulcer (x 25) (Group 2). b. Typical healing margin of the same original type of ulcer four days after gastro-enterostomy (x 60) (Group 8).

pylorus (Mann) into the transplanted jejunum, a portion of intestine containing no appreciable amount of alkali. Typical chronic peptic ulcers formed at the point where the acid ejection from the stomach impinged against the wall of the jejunum.

That the ulcers occurred in the jejunum is not important in itself. This is proved by the original experiments of Mann and Williamson, for they produced ulcers in the duodenum itself in a high percentage of experiments in which they transplanted the bile duct and pancreatic ducts into the lower ileum and left the duodenum in its normal relation with the stomach. Both procedures accomplish the same result, namely, draining the alkali away from the stomach and the intestine into which it empties. The technic of surgical duodenal drainage employed in these experiments was adopted because it was simpler than transplantation of the ducts and still accomplished the same result. The occurrence of ulcer following surgical duodenal drainage seems justly attributable to the absence of alkaline bile and pancreatic juices in the region, and the site of the ulcer seems to be explained by the way in

which the acid ejection impinges directly against a relatively circumscribed area of the intestinal wall.

In the third and fourth groups, areas in the stomach denuded of mucosa, which under normal conditions would have healed rapidly, did not heal well when subjected to the altered conditions set up by surgical duodenal drainage. Delay in healing was most marked on the lesser curvature and in more than 50 per cent. of experiments typical chronic ulcers formed in the areas on the lesser curvature at the same time as similar areas in the same stomach on the greater curvature were healing, either partly or completely. These ulcers were grossly and microscopically almost indistinguishable from gastric ulcers found in man and their site was also the same as that of the greater percentage of clinical gastric ulcers, namely, the lesser curvature.

The lesser curvature has certain anatomic and physiologic peculiarities. Its mucosa is closely attached and relatively smooth, so that it may not readily protect itself by folding and forming the rugæ that are so abundant in the fundus. The lesser curvature is the "Magenstrasse," the gastric street, as it is called by Aschoff and others. The contents of the stomach are impelled against the lesser curvature and propelled along its surface by the force of the muscular contractions of the emptying stomach. When the lines of force exerted by the contraction of the stomach are mapped out, it is apparent that they tend to converge along the lesser curvature.

The gastric ulcers in these experiments formed after the establishment of surgical duodenal drainage, which drained the alkaline bile and pancreatic juices away from the pylorus where they are normally present and precluded the possibility of their regurgitation into the stomach. The ulcers were found on the lesser curvature, the part of the stomach which bears the brunt of the trauma resulting from the process of emptying the acid chyme from the stomach.

In the experiments with jejunal patches in the stomach strikingly similar results were obtained. Patches, with one exception, transplanted into various situations in the normal stomach remained unchanged for long periods. The exception was an ulcer that formed on a patch in the lesser curvature. Patches were then subjected to the altered conditions induced by surgical duodenal drainage. Except for a superficial erosion on a patch in the anterior wall of the stomach, patches in all sites except the lesser curvature remained normal. In three of five experiments typical subacute and chronic ulcers developed on patches in the lesser curvature. Patches of jejunum have been transplanted to an unaccustomed acid environment. This they withstood



FIG. 10.—Growing edge of mucosa in a healing jejunal ulcer seven days after gastro-enterostomy (x 60) (Group 8).

fairly successfully in the normal stomach, although one ulcer did form on a patch in the lesser curvature. Even following surgical duodenal drainage, they withstood the still more inimical environment fairly well except on the lesser curvature. Ulcers formed on three of five patches in this region. The patches may well have served as points of least resistance in the stomach.

In the seventh group of experiments the formation of ulcers in the jejunum following surgical duodenal drainage was followed röntgenologically. Ulcers were depicted well in the examinations, but no abnormalities in con-

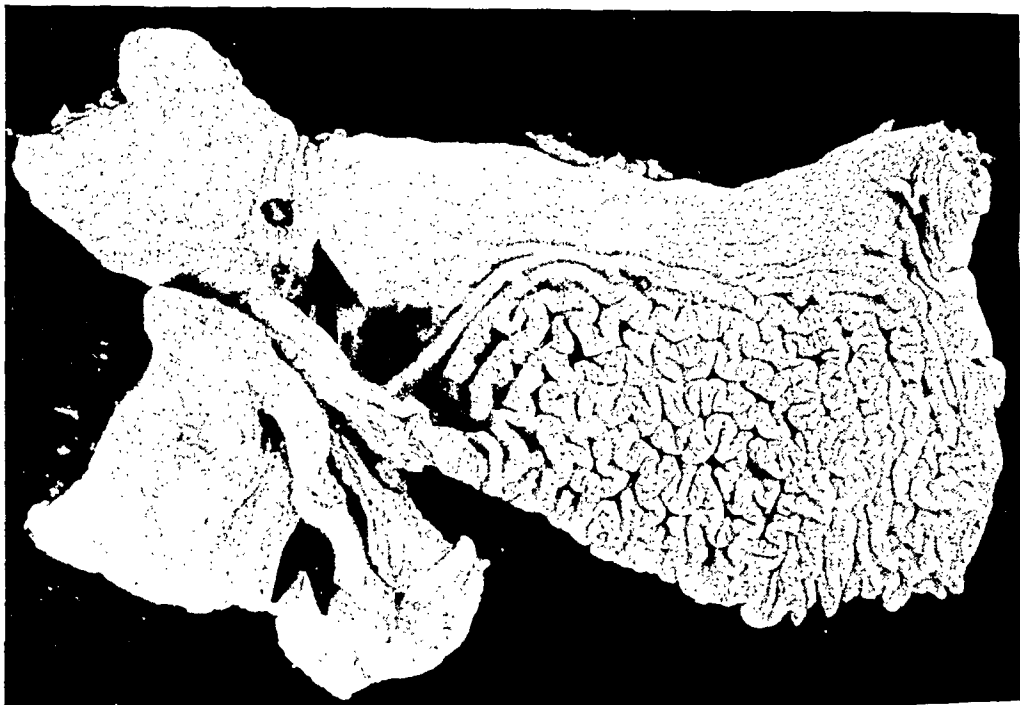


FIG. 11.—Healing ulcer after gastro-duodenostomy (Group 10).

traction or emptying of the stomach were detected as bearing a causal relationship to the ulcer.

In the eighth group of experiments, healing of ulcers induced by surgical duodenal drainage followed simple gastro-enterostomy. In all cases the gastro-enteric stoma was made large so as to drain the greater part of the gastric contents through it. The stoma was made in a loop of jejunum only a short distance from that containing the ulcer and too far away from the point of duodenal anastomosis with the ileum for regurgitation of alkali as far as the gastro-enteric stoma to occur. The gastro-enteric stoma apparently drained most of the acid chyme from the stomach and, by decreasing the amount of acid chyme ejected through the pylorus and the force with which it was ejected against the original ulcer, relieved the strain upon the ulcer and allowed it to heal. This explanation seems to be substantiated by the formation of the new ulcer at the gastro-enteric anastomosis. The new ulcer formed in the efferent loop opposite the stoma at the point where the acid chyme emptying through the gastro-enteric stoma impinged directly against the wall of the intestine.

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In the experiments of the ninth group, ulcers in the jejunum occurred in a few experiments in which surgical duodenal drainage was established after a part of the stomach had been resected. Alkali had been excluded from the field, as in the ordinary type of surgical duodenal drainage. Ulcers did not form as often as before and those found were not chronic. The lesions were more like erosions than chronic peptic ulcers. Other experiments were cited in which ulcers were found after ligation of the common bile duct. Jaundice followed and possibly other upsets occurred, but probably the most important change locally in the duodenum was the exclusion of the alkaline bile from its lumen. Ulcers were found but here again they were not chronic. The alkaline bile had been excluded but the alkaline duodenal secretion and pancreatic juices were still present.

In the last group of experiments three methods of inducing healing of chronic ulcers were cited. Gastro-enterostomy with exclusion of the pylorus induced healing by completely protecting the ulcer from the acid chyme. This method was originally employed by Mann. Healing was also induced by operations in which the alkali in the duodenum was drained back again into the area of the chronic ulcer. In such experiments the acid chyme was still ejected against the ulcer, but nevertheless the introduction of alkali into the area was followed by healing. In the eighth group, healing of the ulcer occurred after gastro-enterostomy which did not introduce alkali into the field of the ulcer but did lessen the amount and the force of the ejections of acid chyme against the ulcer.

In all the experiments, the formation of chronic peptic ulcers of the stomach, duodenum and jejunum followed the withdrawal of alkali from the stomach and intestine into which it emptied, and the site of the ulcer in each case was determined by the point at which the forces of acid ejections converged. Healing of the ulcers ensued when measures were taken to re-introduce alkali into the region of the ulcer or when the forces of the acid ejections of the stomach were diffused or counteracted. The recognition of these factors may prove to be of some value in the etiologic and therapeutic consideration of clinical peptic ulcer.

### SUMMARY

Some of the literature on experimental peptic ulcer has been briefly summarized and the characteristics of acute and chronic and healing peptic ulcers described. Ten groups of experiments have been studied.

The inherent power of the normal stomach and duodenum to heal was verified. In a group of twenty experiments, subacute and chronic ulcers occurred in the intestine just distal to the pylorus in 100 per cent. of experiments following surgical duodenal drainage. It was found that surgical duodenal drainage retarded the healing of denuded areas in the stomach, especially on the lesser curvature. In the experiments of this nature typical subacute and chronic ulcers formed on the lesser curvature in as high as 62.5 per cent. of experiments. Large numbers of patches of jejunum of whole

thickness and with intact mesenteric circulation when transplanted into various regions in the walls of the stomach remained normal, except for one experiment in which an ulcer formed on a patch in the lesser curvature of the stomach. Patches that had remained normal for long periods were then subjected to the altered conditions following surgical duodenal drainage. Except for a superficial erosion on a patch in the anterior wall no ulcers formed on patches in other situations than the lesser curvature. In three of five experiments chronic ulcers formed on patches in the lesser curvature.

Röntgenologic studies were made of chronic ulcers induced by surgical duodenal drainage. Ulcers were well depicted by fluoroscopic and röntgenographic examinations, but no disturbance in the motor mechanism of the stomach could be detected as having a causal relationship to the formation of ulcer.

In a group of chronic ulcers following surgical duodenal drainage, healing was induced by gastro-enterostomy. The formation of new ulcers in the efferent loop demonstrated that the large gastro-enteric stoma had assumed the greater part of the load of draining the acid chyme from the stomach. The original ulcers, being thereby proportionally relieved of irritation, healed.

In a few experiments ulcers followed certain other procedures which decreased the amount of alkali present in the duodenum. In experiments of the last group healing of chronic ulcers followed the re-introduction of alkali into the region of the ulcer.

In the author's experiments the formation of chronic peptic ulcers of the stomach, duodenum and jejunum followed the withdrawal of alkali from the stomach, and intestine into which it emptied, and the site of the ulcer in each case was determined by the point at which the forces of acid ejections converged. Healing of the ulcers ensued when measures were taken to re-introduce alkali into the region of the ulcer or when the forces of the acid ejections of the stomach were diffused or counteracted. The probable bearing of the recognition of these factors in the etiology and treatment of clinical peptic ulcer was mentioned.

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# TREATMENT OF ACUTE CHOLECYSTITIS \*

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ACUTE cholecystitis may be compared to acute salpingitis in that it rarely kills if treated conservatively. Surgical writers are prone to compare it to acute appendicitis, but this comparison is not in consonance with the clinical facts. Acute appendicitis is a lethal disease because it so frequently results in diffuse peritonitis. Acute cholecystitis does not cause widespread peritonitis unless a perforation occurs early in the attack and the contents of the gall-bladder are spilled into the free peritoneal cavity, fortunately such a perforation is a rare event. When the gall-bladder is acutely inflamed it is very quickly walled off—the liver, omentum, parietal peritoneum and transverse colon form a barrier against the spread of infection. W. J. Mayo<sup>1</sup> speaks of this protective process and also states that the escape of septic material from the gall-bladder, and bile-ducts has a tendency to set up a rather mild form of peritonitis. Deaver and Burden<sup>2</sup> attribute the rarity of acute perforation to both the protection of surrounding structures and to the fact that the bile tension in the gall-bladder is never high.

Occasionally cholecystitis requires surgical treatment during the acute attack, but it is my conviction that as a rule the operation should be avoided until the signs of active inflammation have disappeared. However, the patient belongs in a hospital under the observation of a surgeon. Rest, morphine, ice packs and the administration of large quantities of water and glucose suffice, in almost every instance, to limit the inflammatory process. The specific action of glucose in combating the effects of damage to the liver has been emphasized again by the work of Mann and Magath.<sup>3</sup> In the severer gall-bladder infections glucose should be given intravenously. Operation is indicated in any case when the diagnosis is questionable or if a perforation is suspected. The gravest danger in this conservative treatment is the possibility of a mistaken diagnosis; I have seen acute appendicitis, mechanical ileus and a perforated ulcer diagnosed as cholecystitis and abstention from operation practiced. I have lost patients who were operated upon in the acute stage of cholecystitis and I now believe that these patients might have lived had operation been postponed. Wilkie<sup>4</sup> has shown that acute inflammation of the gall-bladder is frequently associated with signs of infection at the base of the right lung, and in my experience pneumonia is one of the chief causes of death after operations performed during the acute attack. I have had one death from acute perforation of the gall-bladder, this perforation was recognized early, but permission to operate was refused. I am advising a conservative course in all types of acute inflammation of the gall-bladder if I believe that the disease is limited to the organ and its immediate neighborhood. As a matter of fact, no finite mind can distinguish

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between most cases of acute catarrhal inflammation and an empyema. When I am impelled to operate during the acute stage the gall-bladder is usually so damaged that I perform a cholecystectomy. I admit that my pre-operative intentions are usually to do a simple drainage operation, but I have not found a cholecystostomy to be an easy procedure in these cases.

The literature of no other abdominal, inflammatory condition presents so wide a difference of opinion, among surgeons of experience, as to the indications for operation. And among those who advocate immediate intervention there is a marked divergence of views as to the operation of choice.

In an English text-book we find Walton<sup>5</sup> comparing cholecystitis to appendicitis and insisting upon immediate cholecystectomy. He claims that if the operation is performed within twenty-four hours of the onset that it is as free from danger as the corresponding one performed for appendicitis. Bland-Sutton<sup>6</sup> asserts that to operate for acute cholecystitis and not remove the gall-bladder is as reprehensible as operating for gangrenous appendicitis and leaving the appendix. A "Leading Article"<sup>7</sup> in the British Medical Journal commented on this assertion and stated that "the practice of this operation (cholecystectomy) is admittedly no less beneficent in the acute forms of gall-bladder disease than when the infection is of slight intensity," but a warning is given of the danger of irreparable harm from injury to the ducts or vessels. Symonds<sup>8</sup> vigorously refuted these statements claiming that they are not based on correct pathology and are inconsistent with clinical experience and he concluded that urgent operation is never called for. Moynihan<sup>9</sup> waits when possible until the interval and then removes the gall-bladder. Wilkie<sup>10</sup> is of the same mind, but in patients over sixty years of age, if the symptoms do not show evidence of subsiding within thirty-six hours of the onset of the attack, he operates and drains the gall-bladder. In younger subjects if the acute symptoms do not subside after a few days and when there is an empyema of the gall-bladder, he operates and, as a rule, does a cholecystectomy.

In France the Lyons school, led by Leriche and Cotte, insist that this disease should be treated by an immediate cholecystectomy. The subject was discussed at two sessions of the Lyons Surgical Society<sup>11</sup> in 1923. It appears from this discussion that the conduct which then prevailed in France was to practice a minimum of intervention during the acute attack, in an emergency a cholecystostomy was performed to be followed by a secondary cholecystectomy. At one of these sessions Chalier<sup>12</sup> reported two cases of acute cholecystitis, one grave and the other serious, treated by immediate cholecystectomy and closure of the abdomen without drainage. It is notable that the advisability of this procedure was not questioned. A critical review of the more recent French literature convinces me that Soupault and Thalheimer<sup>13</sup> are correct in stating that the present tendencies in France are in favor of an intervention without delay in the course of a serious attack of acute cholecystitis. In fact, I have not been able to find a French surgeon who is now advocating abstention from operation; however, the nature of the

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intervention is still the subject of active discussion. Lecéne<sup>14</sup> now recognizes that cholecystectomy has undeniable advantages in acute cholecystitis, but as it may be dangerous, in many of these cases he is content to practice a cholecystostomy under local anaesthesia. Pauchet<sup>15</sup> recently recommended drainage in the acute stage to be followed, after the infection has disappeared, by the removal of the organ. This is also the opinion of Mocquot,<sup>16</sup> but Berger<sup>17</sup> appears to believe that the second operation is unnecessary. Cuneo<sup>18</sup> has taken the position, which seems to be fairly common among French surgeons, that if the whole gall-bladder wall is involved in the inflammatory process (pancholecystitis of Lecéne) that drainage alone is not enough to stay the progress of the acute disease. Gaudin<sup>19</sup> is impressed by the results of immediate cholecystectomy and believes that the subserous removal during the acute stage presents no notable difficulties for any operator, however lacking in experience he may be. Savariaud<sup>20</sup> believes that both operations have their indications but he also practices cholecystenterostomy in certain cases.

Most German surgeons, if we can believe their most recent system of surgery (Heller<sup>21</sup>), postpone operation until the interval and they feel that operation is only indicated by progressive phenomena. In March, 1927, Dührssen<sup>22</sup> stated that this is the practice at the Berlin Charité where operation is performed eight days after the disappearance of the last acute symptoms; perforation, icterus with grave infection and involvement of the peritoneum being the absolute indications for interference during the attack. Interest in this question was stimulated by the conservative papers of Enderlen<sup>23</sup> and Hotz which were presented at the 1923 meeting of the German Surgical Association. Hotz demonstrated that, in the cases reviewed, the mortality of operation performed during the attack was double that of operation performed during the remission. In 1924, the Medizinische Klinik<sup>24</sup> published the results of a questionnaire, covering this subject, which had been submitted to the leaders of German Surgery. A careful reading of the replies convinces me that most of these men are not as conservative as the above statement would indicate. While the majority of them prefer postponing operation until the acute stage has passed, practically all of them operate if the symptoms are unusually severe or if an empyema is suspected. This appears to be the position of Enderlen, Küttner, Kappis, Schmieden, Perthes, Anschuetz, Laewen<sup>24</sup> and Koerte.<sup>25</sup> Operation with them is almost a synonym for cholecystectomy. Kirschner<sup>26</sup> is the chief German protagonist of early cholecystectomy. He believes that the operation is easier to perform during the stage of active inflammation and he advances the naïve reason that the patient is more willing to submit to operation during the acute attack. Kirschner does not urge operation within the first hours after the patient is admitted to the hospital, but usually takes one day for pre-operative preparation. Stich<sup>24</sup> holds that operation is justifiable only in the first twenty-four or forty-eight hours of the acute seizure.

American surgeons are likewise diverse in their views on this subject.

Haggard<sup>27</sup> states that the rarity with which patients ever die from an acute cholecystitis when left alone should compel us to avoid operation in the acute stages, which is notoriously dangerous. McGuire<sup>28</sup> laments the fact that there is no general rule to guide us in these cases, unless the cholecystitis is attended by symptoms which cause alarm he is in favor of waiting until the acuteness of the infection subsides. Two authors discuss this topic in the same number of a surgical periodical. Deaver,<sup>2</sup> in one article, writes that when possible operation should be deferred until the subsidence of the acute attack, but if interference is demanded the acutely inflamed gangrenous or perforated gall-bladder should be removed whenever possible. Cave,<sup>29</sup> the other essayist, advises waiting to see if there is a "cooling off," but if after thirty-six or forty-eight hours the symptoms do not improve, a cholecystostomy is indicated, and he warns of the grave danger of removing "the especially acutely inflamed partially gangrenous or ruptured gall-bladders." Bunts<sup>30</sup> remarks that no operation should be performed in the case of an acute attack unless empyema is suggested; when the patient's condition is grave a cholecystostomy should be done. Lyons and Judd<sup>31</sup> write, in 1923, if the condition is acute it is better to wait until the attack subsides before operation. W. J. Mayo<sup>32</sup> recently described a method of performing cholecystectomy in acute cholecystitis. In 1925 there were fifty-four operations at the Mayo Clinic<sup>33</sup> for acute cholecystitis, fifty-one were cholecystectomies and three were cholecystostomies. Behrend<sup>34</sup> teaches that one should not operate for empyema of the gall-bladder until the temperature has been normal for several days and the gall-bladder is freely palpable without pain. Muller<sup>35</sup> does not approve of immediate operation in acute empyema, ordinarily he delays operation until the temperature reaction and pulse rate are falling and the symptoms of rigidity and tenderness become localized in the gall-bladder region. It is the general practice at the Massachusetts General, according to Richardson,<sup>36</sup> to let the attack quiet down and the patient recover his balance before operating unless some feature of the cases makes it particularly urgent. Lewis<sup>37</sup> informs me that about the same practice obtains at the Johns Hopkins Hospital and he feels that in most instances the urgent cases should be drained. Archibald<sup>38</sup> writes that at the Royal Victoria Hospital they usually prefer to wait, unless threatening symptoms are present suggesting gangrene, that is unusually rapid pulse and prostration and then they do nothing more than a simple drainage. Archibald remarks: "I consider cholecystectomy in acute cholecystitis as unwarranted danger." Crile<sup>39</sup> does not like to operate during the acute attack, but inasmuch as it is rather difficult to foresee whether or not a rupture may occur, he generally operates and drains the gall-bladder. "In going over our gall-bladder statistics here," he writes, "we have been rather impressed by the large percentage of cures following a cholecystostomy in these cases." McArthur<sup>40</sup> is of the opinion that operation may be delayed for a few days if the pulse temperature and subjective symptoms permit. He believes that if the patient is in good condition, a cholecystectomy should be done; if in desperate con-

dition, with toxæmia and gangrene, drainage is advisable. Coffee<sup>41</sup> has no general or set rule letting each case be governed by itself.

In conclusion I wish to express the hope that some day surgeons will be fairly unanimous in their views on the treatment of acute inflammations of the gall-bladder. It is obvious that we can follow whatever plan of treatment we may choose in the mild attacks of the disease and it will make but little difference in the outcome. Certainly, it is only in severe cases that the question of operation becomes of major importance. At present I feel that I have ample support in my position that operation is very rarely indicated.

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# POINTS IN THE TECHNIC OF OPERATIVE REMOVAL OF KIDNEY STONES\*

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IN THE course of many years of work in the removal of kidney stones, in which many hundreds of cases have been operated upon, I have been able to gradually work out a more and more satisfactory technic. The object of the kidney stone operation is, to remove all calculous material and at the



FIG. 1.—Unilateral renal lithiasis illustrating types of stone removed by pyelolithotomy, with X-ray control of exposed kidney in operating-room, complete removal being obtained in this way.

same time to spare the kidney as much as possible, so that its functional parenchyma is damaged not at all or but slightly.

Before approaching the operative treatment of kidney stones, the surgeon must know whether the patient's kidney is infected or not; whether it is sufficiently preserved to be a usefully functioning organ, and is worth saving; whether the other kidney is able to carry on, should a nephrectomy be necessary. Also, whether the involved kidney is the only kidney that the patient possesses. All these factors are of great importance, and must be

borne in mind by the operator. For instance, if a kidney is infected and the stone is removed by nephrotomy, sutures passed through such a nephrotomized kidney may lead to secondary diffuse kidney infection, so that the kidney must be subsequently sacrificed. Moreover, if the stone is in a solitary kidney, such kidneys should be handled very gingerly and not dislocated from their normal positions, the operation being done *in situ*. Then, too, if the functional tests show that the organ is practically negligible and full of pus, unless one finds adequate parenchyma at operation it may be advisable to remove the kidney and the stone together.

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In looking over a series involving 271 stone cases between the years of 1921 and 1925, I find that in 18 per cent. the kidneys were so badly destroyed that it was inadvisable to save the organ. In 5 per cent. of the cases, owing to the fact that the other kidney was badly diseased or that the stone was in a solitary kidney, the stones were removed without dislocating the organ. In all the other cases, the operation of choice was pyelotomy or nephrotomy, or the two operations combined. Of late, pyelotomy is becoming more and more popular on my service, even though it is frequently associated with a small nephrotomy incision, which may be used not only for extracting

small calculi in the calyx, but also for drainage of the kidney pelvis. In reviewing my personal very recent records, in 38 kidney stone cases there were 23 pyelolithotomies, 6 pyelolithotomies combined with nephrotomies, one nephrolithotomy and 8 nephrectomies. This very definite swing toward pyelotomy for all cases is entirely due to our X-ray control of the exposed kidney on the operating table,



FIG. 2.—Unilateral renal lithiasis illustrating types of stones removed by pyelolithotomy, with X-ray control of exposed kidney in operating-room, complete removal being obtained in this way.

which makes for complete removal of all stone material. Moreover, the operative approach through the pelvis meets the other desideratum mentioned above—it spares kidney parenchyma.

To carry out these two principles—to remove all the calculous material and to spare as much kidney parenchyma as possible—it is necessary to make an adequate exposure, a real surgical exposure of the kidney, which I find is best done through an inverted “S” incision in the lumbar region, beginning close to the eleventh rib at the margin of the erector muscle and passing obliquely down through the lumbar space between the crest of the ilium and the last rib. Paralleling the last rib, it should extend forward and downward in front of the anterior spine as far as is necessary to get an adequate approach. The kidney being exposed through this incision, is gradually liberated from its perinephric fat; adhesions to the upper pole should be carefully ligated before being cut, and then the kidney can usually be completely liberated and dislocated unless there are contra-indications to this procedure. This usually permits the operator to raise the organ well up to the muscular or skin plane. Having exposed the kidney in this way, the ureter should regularly be exposed and a double loop of heavy catgut should

be thrown around the ureter to constrict its lumen, which prevents fragments which may break off from the stone or stones slipping into the ureter and subsequently causing obstruction or symptoms due to the existence of fragments in either the lumbar or the pelvic ureter.

With the kidney well exposed, the great majority of stones can be removed, often without fragmentation, by a posterior pyelotomy incision, which if necessary can be prolonged (usually without striking any sizable vessels) well into the adjacent parenchyma. If an abnormal vessel interferes with this approach, it can usually be pushed aside, and only rarely has to be ligated. Occasionally it may be simpler to make an inferior pyelotomy approach, dislocating the lower pole cephalad and incising the pelvis on this surface. Much more rarely is one compelled to do an anterior pyelotomy, pushing the vessels out of the way, or even without dislocating the vessels.

The removal of the stone or stones through the pyelotomy incision, though often very simple, at times may be most difficult. For instance, in a very stout patient with a small movable stone, after dislocating the kidney one may not be able to recognize the site of the stone, even though in the X-ray picture it seemed to be in the pelvis. In such cases, the stone having escaped into a more or less dilated calyx, it is often easier to replace the kidney and follow up the ureter to the pelvis and do a pyelotomy *in situ*, allowing the finger or a stone curette or forceps to locate the stone, and then extracting it. In other cases, the numerous stones scattered throughout the calices may be difficult to remove, as the neck of a calyx which harbors stones may be stenosed and one can not feel with one's fingers the calculi retained in such a calyx. With an X-ray film of the exposed kidney taken then and there (to which I expect to refer later), the location of these stones can readily be ascertained and they can be removed with ease through a small nephrotomy incision. There are other cases in which the stone is pyramidal in shape, with the base of the pyramid in the calyx and the apex extending into the pelvis, where it may be united with a well-formed pelvic stone. To try to deliver the base of such a stone through a narrow caliceal neck is liable to damage the adjacent kidney tissue. And in these cases again it is wise to make a small nephrotomy incision and deliver the stone through this incision.

All in all, it is surprising how readily one can deliver through a large pyelotomy kidney stones of the most remarkable and distorted shapes by gently twisting and rocking the stone as the kidney is firmly held. And these forceps deliveries, if gently carried out, can often be done without any damage to the stone, without any fragmentation, and without any real injury to the kidney itself. Fragmentation, which used to be dreaded because of the danger of leaving pieces of stone in the kidney, occasions no such feelings since X-ray control is available.

After I have cleared out such a kidney by the above manœuvres, I regularly wash out the organ with a strong stream of water introduced through a large catheter, so as to clean out any sand or fragments from the pelvis or calyces. To avoid wetting the patient as well as the operator during this



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irrigation, a suction tube is placed in the wound, which takes up the water as rapidly as it runs out alongside the catheter, either from the nephrotomy or the pyelotomy incision. Having apparently removed all the stones and all the fragments, during the last three or four years I at first controlled the completeness of my operation by fluoroscoping the kidney. (Brewer, Braasch.) This has not proven very certain and reliable, and repeatedly small stones—even one to two dozens—have been removed from the kidney directly after the fluoroscopic examination had shown that the kidney harbored no more calculi. Since Quinby had such excellent results with films, I have given up fluoroscopy and taken pictures for immediate development close to the operating room of all cases of this type. And though up to date I have had not more than 24 to 30 of such controls † on the operating table, the value of this coöperation with the X-ray department is so great that no patient with a complicated stone in his kidney is taken to the operating room for its removal without making sure that such X-ray control is available and ready.

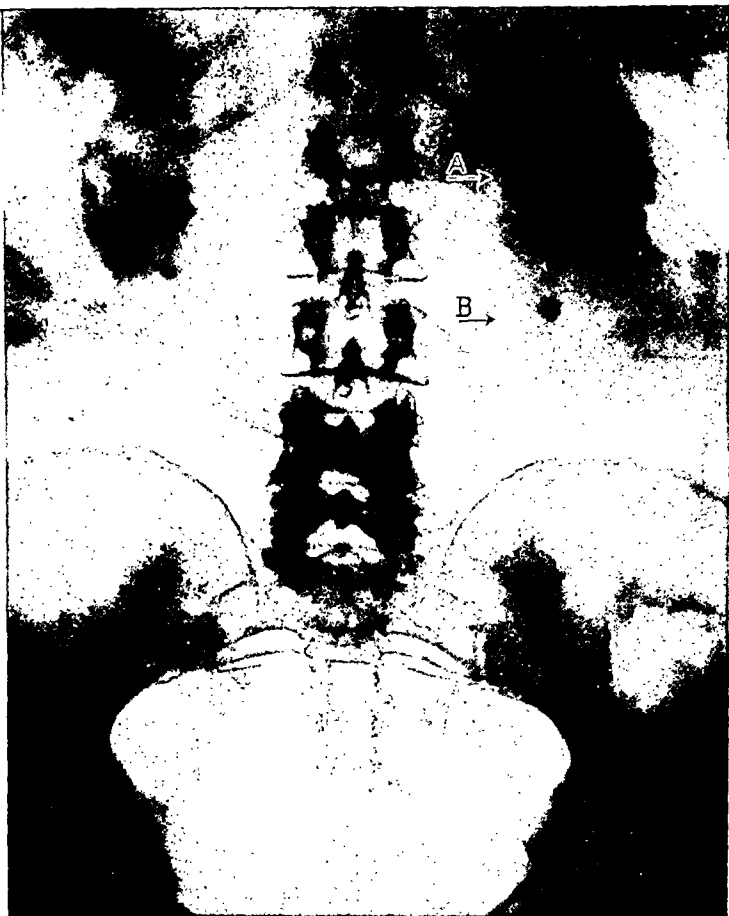


FIG. 3.—Bilateral renal lithiasis illustrating types of stone removed by pyelolithotomy with X-ray control of exposed kidney in operating-room, complete removal being obtained in this way.

Naturally, in patients with single small stones in the pelvis of the kidney, or even in the calyx, we do not insist upon such X-ray control. Nevertheless, during recent years probably 30 cases fell into the category of those that should be controlled on the operating table and frequently when the operator had the impression that all stones were removed, the X-ray film proved him to be incorrect and located one or more stones in some part of the kidney, which the operator had not been able to detect. These stones were then almost regularly removed by a nephrotomy into a closed calyx, or by reexploration of the pelvis proper.

The importance of this control cannot be exaggerated, as any fragments left behind make for an incomplete operation. And moreover, there is nothing more disheartening to a surgeon than to have operated, for instance,

† Four more cases have been thus controlled in the last month.

for three or four stones which are definitely present in the X-ray, and at the end of the operation have only one such stone to show his patient. Years ago, before we had this valuable adjunct, whenever I was in this predicament and had not recovered all the stones I made a stab nephrotomy, hoping that what was overlooked might come out through or alongside the tube following subsequent irrigations. In one case where I was particularly chagrined to find only one stone when four small stones had been shown in the X-ray,

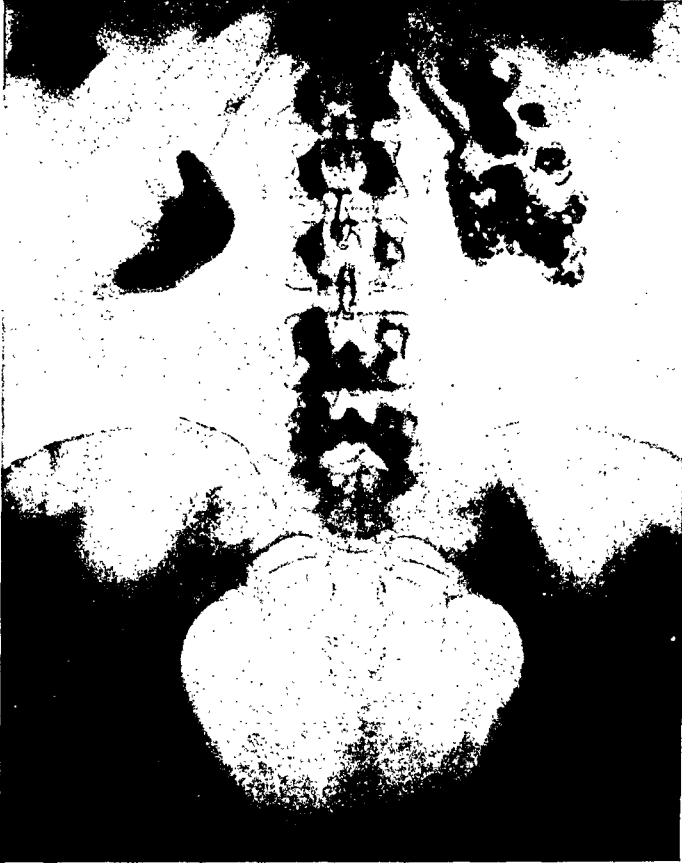


FIG. 4.—Bilateral renal lithiasis illustrating types of stone removed by pyelolithotomy, with X-ray control of exposed kidney in operating-room, complete removal being obtained in this way.

well to control the bleeding from the kidney parenchyma, lest the patient, in the course of the operation, lose an excessive amount of blood, as is so frequently observed in most operating rooms where nephrolithotomies or exploratory nephrotomies are performed. To avoid loss of blood—in other words, to do the operation under almost complete ischæmia—I have thrown a soft rubber tube about the kidney pedicle, crossing the two loops of the rubber tube on the anterior surface of the pedicle, and at the crossing placing an artery forceps. This constriction of the pedicle prevents loss of blood from the kidney, and one can incise far and wide, making a complete exploration, even from pole to pole, without any risk of hemorrhage on the operating table. In one such case I found scattered through the pelvis and calyces over fifty bizarre-shaped oxalate stones, many of them looking like jackstones, which

the three other stones were recovered in this way. However, this good luck does not always follow a nephrotomy, and X-ray control has done away with this haphazard method of looking after our failures.

If the pyelotomy approach is impossible, due to the adhesions about the pelvis and short pedicle, or due to the distribution of the stones in the parenchyma, it may be necessary to do a primary nephrolithotomy to reach the calculi scattered through the kidney. For these wide nephrotomies, as opposed to the small nephrotomies associated with pyelolithotomy, it is

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could not possibly be delivered from the pelvis, as it was impossible to deliver the organ adequately.

Having removed the stones from these cases by wide nephrotomy, an X-ray film can readily be taken, even though the organ cannot be well dislocated. However, one may have difficulty in getting a complete picture due to the fact that it is hard to introduce a film well into the patient's body and so cover the whole kidney. It should be noted that in taking these exposures, a marker (either a needle, or an artery forceps, or both) should be placed upon or in the kidney, to mark the upper or lower pole and to give the operator some idea of the relative distance any overlooked stones may be from the marker.

Many of these kidneys which have been the site of stones are liable to be adherent to the perinephric fat, and as one attempts to deliver them the capsule of the kidney is stripped back, which, if one finally succeeds in delivering the kidney, compels the operator, if he attempts to do a pyelot-



FIG. 5.—Bilateral renal lithiasis illustrating types of stone removed by pyelolithotomy, with X-ray control of exposed kidney in operating room, complete removal being obtained in this way.

omy, to first cut through the reflected capsule, then the adherent perinephric fat, and then the fat surrounding the pelvis of the kidney, and finally the pelvis itself, before reaching the stone. This complicated situation, however, is readily met if one bears in mind the pathological and the anatomical conditions created by stripping back the capsule.

After doing a nephrotomy in this way, the open vessels on the cut surface can readily be tied by passing a suture on a fine needle armed with catgut around the exposed vessel twice, and then tying it. It is always wise to use as few sutures as possible in closing the nephrotomy incision, both to avoid infecting the parenchyma, as most of these kidneys harboring stones are liable to be mildly infected, as well as to avoid strangling too much of the kidney parenchyma, which may convert what was a fairly useful organ into a functionally poor one. If the capsule is still adherent, it may be possible to make use of the resistance that it offers and apply mattress sutures of

chromic gut to close the incision, taking a few sutures well in from the convexity and a few more nearer the convexity. If, however, the capsule has been stripped back, no such support is present to prevent sutures cutting into the parenchyma; and in these cases it is important to underpin sutures as described by me ‡ some years ago, either with fat, fascia or muscle, which absolutely prevents any cutting into the parenchyma when the sutures are tied. It seems to me that these double chromic gut sutures underpinned with fat, etc., strangle less tissue than the mattress sutures; and even in those kidneys with capsules attached, I am inclined to use this type of underpinned suture, rather than the mattress suture.

After one is satisfied that all fragments are recovered, and after one has sutured the kidney incision, the rubber ligature on the vascular pedicle is loosened, and the replaced kidney is compressed *in situ* with gauze for a few moments, to be sure that no active bleeding is taking place. In some of these cases, especially the badly infected ones, it may be wise to leave a small calibred tube through the partly sutured nephrotomy incision in the pelvis; and this also may be indicated when it is impossible to accomplish an absolutely perfect suture hæmostasis to avoid disruption of the rest of the sutured wound in the kidney.

As far as the pyelolithotomy incision itself is concerned in the first group of cases, it seems to be quite immaterial whether the pelvis is carefully closed by sutures or not. Repeatedly the pelvic incisions made in this way have not leaked though no closure has been made, and on the other hand some pelves which have been carefully sutured and then covered with fat have leaked for days after the operation. In general, one places some plain catgut sutures in the pelvic wall to approximate the incision, especially if a wide pyelotomy has been made. If a redundant pelvis has been excised and a pyeloplasty performed, it is regularly carefully sutured.

Before closing the pelvis on the wide nephrotomy incision, the double loop on the ureter should be removed, after careful palpation of the ureter above this loop, as every once in a while one finds a stone fragment in this short piece between the pelvis and the ligature. This can either be squeezed up into the pelvis and removed, or it can be scooped out with a small blunt spoon. In closing the parietal wound, it is wise to provide some drainage with a rubber dam, so that one has control of whatever leakage or bleeding may take place, and if a tube has been placed in the nephrotomy incision it should be long enough to emerge well out of the wound, for self-evident reasons.

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## CYSTOSCOPY REACTIONS

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Cystoscopy reactions, that is rises of temperature with various concomitant symptoms after cystoscopy, are common. To our knowledge, there are no definite data which make the exact incidence of cystoscopy reactions clear, but the majority of observers agree that such reactions are not only common, but that they may also be severe. There are a few statements in the literature which almost deny their occurrence provided proper precautions are taken, but these statements may be due to the fact that the authors considered only very severe reactions with bad end results. In the Urological Service of Bellevue Hospital cystoscopy reactions have been fairly common. Bad end-results have been rare, but in quite a number of cases the reactions have been disturbing nevertheless. Some patients have become alarmed and have refused further cystoscopic examinations and treatments; in many instances, varying degrees of discomfort and pain have followed cystoscopy.

One may question whether cystoscopists are taking all possible precautions against reactions. To do so they must know the fundamental causative factors. With the hope that some light may be shed on this subject, an investigation into the more immediate causes for cystoscopy reactions and disturbances has been made.

The urological literature contains many more or less vague warnings against the indiscriminate use of cystoscopic and pyelographic examination methods. Very little has been said which is definite and unequivocal. It is perhaps easiest to present the various opinions classified as to the points of maximal importance.

Almost everybody stresses the importance of sterile procedure and many contributions have been made to insure at least relative asepsis for cystoscopy. First, let us consider the instruments. The cystoscopes in common use cannot be sterilized in a bacteriological sense, but the new cystoscope by Leiter<sup>1</sup> is said to be sterilizable by heat, and Joseph's new cystoscope has at least a sheath which may be boiled.<sup>2</sup> Young's new cystoscope allows for aseptic manipulation after its introduction.<sup>3</sup> The ureteral catheters also cannot be absolutely sterilized without quick deterioration. The various methods of chemical sterilization are all open to criticism, especially if the lumen is not particularly cared for. There are no catheters made to our knowledge which can be boiled for a sufficient length of time to insure sterility. The danger of contaminating the catheters during their handling has been cleverly obviated by Grant,<sup>4</sup> who uses sterile paper covers, and by Kidd,<sup>5</sup> who uses "silk petticoats". The above-mentioned instrument by Young is the only one which takes care of two common areas of contamination, namely the rim of the

ocular which is contaminated by the eyebrows and in turn contaminates the hands, and the light cord connection which in all other instruments is not sterile to begin with. As to the patient, few authors demand a strictly aseptic preparation, *i.e.*, shaving and scrubbing of the genital area followed by an antiseptic application. The urethra of the male patient cannot be made sterile unless the most meticulous preparation is carried out. Therefore unless the most thorough and persistent efforts are made, combining all or nearly all the suggestions set forth, cystoscopy is never an aseptic undertaking.

The advice as to trauma is usually couched in general terms suggesting care and celerity. The admonition not to use too much pressure in filling a kidney pelvis for pyelography has been generally accepted and is followed by the employment of gravity for this purpose. Joseph<sup>6</sup> apparently alone lays particular stress on the importance of trauma. He uses a special small cystoscope of size No. 15 F. and advises the routine use of small instruments even if the optic field is small and the technic much more difficult.

The pyelographic media in use and as used at present rarely cause severe reactions. These solutions are hardly discussed any more in this connection, very much in contrast to the former vehement criticisms of collargol and similar solutions, as the former are but little irritating and may be boiled without deterioration. The present attempts to introduce lipiodol and similar heavy emulsions do not seem to find followers.

The double pyelogram is still a debatable procedure. The ban placed upon it a few years ago by Keyes,<sup>7</sup> Braasch,<sup>8</sup> and others has been lifted by some workers providing certain precautions are taken, but apparently it is still looked upon with misgivings by many.

The more specific contra-indications against simple cystoscopy and pyelography vary so greatly that little can be gained from their restatement. Warnings not to examine cystoscopically patients with prostatic hypertrophy may be contrasted with the advice offered by others to thus examine all such patients before operation. Some employ cystoscopy early in the treatment of pyelitis while others warn against cystoscopy during high temperature or the existence of an acute infection of the urinary tract. In tuberculosis many authors warn against pyelography, some warn against ureteral manipulations, and some even against the introduction of a rigid instrument into the male urethra. Westerborn<sup>9</sup> reports seven cases in which the introduction of a sound or a cystoscope produced miliary tuberculosis, resulting in death; all these cases suffered from genital tuberculosis aside from the kidney infection. Keyes<sup>7</sup> warns specifically against pyelography in hydronephrosis unless the patient can be operated upon immediately, should it become necessary. Many authors think an infected bladder a contra-indication to ureteral instrumentation and others advise not to touch the normal ureter in cases of unilateral kidney infection. Klika<sup>10</sup> and Narath<sup>11</sup> have tried to elaborate technical procedures to make ureteral manipulations safe under these conditions. Braasch<sup>12</sup> warns against the catheterization of a single kidney and ureter and illustrates his warning with reports of fatalities. Prostatitis is not

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particularly mentioned as a contra-indication against cystoscopy, but acute cases rarely necessitate cystoscopy. The chronic prostatic infections, however, which are so commonly found concurrent with bladder and kidney infections, surely should have a bearing on the question of cystoscopy reactions.

It is difficult to attack a problem of this kind experimentally at first. But a previous analysis of cases cystoscopically examined under definite conditions promised some elucidation and was therefore undertaken. The influence of asepsis on the percentage of cystoscopy reactions cannot be clarified in this manner, but the question of trauma—a factor which depends greatly on the operator—could be solved by the comparison of different operators and their results. The material collected also throws some light on certain debatable contra-indications and contains a few cases which are remarkable from our present point of interest.

The cases which form the material for this report have been personally observed in the wards of Bellevue Hospital. All the cystoscopies which are considered include ureteral instrumentation, some with and some without pyelography. The technic used was uniform except for slight individual variations. Thorough scrubbing of the hands, cleansing of the genital area with soap and water, formaldehyde sterilization of all instruments, immersion of the cystoscope into mercury oxycyanide solution before use, and medication of the patient with hexamethylenamin were routinely employed. All solutions and all instruments which could be boiled were sterilized by heat.

Nothing was considered a positive cystoscopy reaction in this report unless the temperature rise within twenty-four hours exceeded the highest temperature of the three preceding days by two degrees F., and unless no other cause for the rise in temperature could be found. Other symptoms and signs as hæmaturia, dysuria, pain in the kidney region, and so forth were taken cognizance of, but were not recorded as reactions *per se*.

The examinations of three operators only, members of the resident staff, are included in the group. Each man had about the same amount of experience in urological work. All of them were well versed in urethral manipulations. Their particular work was observed in the hope of finding in their technic an explanation of variations in their reaction percentages, should such occur.

Altogether there were 328 cystoscopies with 63, or 19.2 per cent., reactions. The three operators used the same technic as far as sterility was concerned; they differed, however, in skill and judgment. Operator No. 1 was relatively insistent on complete investigations, though prolonged and difficult, and considered a patient's discomfort less than operators No. 2 and 3. His skill in instrumentation was average. Operator No. 2 was more composed and more considerate of the patient. His skill was fair and his touch more delicate than that of the first operator. Operator No. 3 possessed unusual skill and gentleness in manipulations, and exercised good judgment concerning the length of cystoscopic procedures. Operator No. 1 had 35

reactions in 134 cystoscopies or 26.1 per cent., operator No. 2 had eleven reactions in 62 cystoscopies, or 17.7 per cent., and operator No. 3 had 17 reactions in 132 cystoscopies, or 12.8 per cent. Of course the quality of the operator is to a certain extent imponderable, but these differences in results can hardly be explained in any other way than by reference to individual skill and judgment. All three operators used the same instruments on patients whose pathological conditions were much the same in all three groups.

An attempt was then made to group the whole material according to different viewpoints, hoping that this would throw some light on the situation. The first grouping, namely into males and females, did this rather strikingly. There were 281 males with 61 reactions, or 21.7 per cent., and 47 females with two reactions, or 4.2 per cent. The most plausible explanation for this very marked discrepancy lies in the anatomy of the urethra. The forcible straightening out of the tract in the male must exert a great deal of traction and pressure on the bulb and on the posterior urethra; the prostate and the bladder neck are also necessarily traumatized. On the other hand, the female urethra is relatively very short, is easily instrumented, and does not have a prostate. This suggests that the percentage of reactions from infections of the upper urinary tract are apparently far less common than from infections of the lower tract. Of course it is very difficult actually to draw the line between lower and upper tract infections, but we are here concerned only with the starting point, and about this there can be little doubt. The additional analysis of a small group of observation cystoscopies in which the ureters were not touched tends to confirm this. Of 33 cystoscopies in males by the previously mentioned observers seven, or 21.2 per cent., were followed by a reaction.

The question whether or not a previous infection of the urine would predispose toward cystoscopy reactions also arose. Separating the material into two groups, with non-infected and with infected urine, we get the following results: Non-infected cases: 189 with 41 reactions, or 21.7 per cent.; infected cases: 139 with 22 reactions, or 15.8 per cent. It is possible that our separation is not absolutely accurate; it is based only on the microscopic examination of the urine for pus. The classification seems to show that infection of the urine *per se* does not increase the risk of cystoscopy. If the difference of 6 per cent. is significant at all, it is in favor of the infected cases. Immunity, local or general, may be responsible. Many of the cases had unilateral kidney infections, and in all these cases the other ureter was catheterized, but there has not been a case where the other kidney has been known to have become infected through the examination.

Whether pathological conditions of the urinary tract have anything to do with cystoscopy reactions is answered by the following computation. Pathological cases: 279 with 55 reactions, or 19.7 per cent.; normal cases: 49 with 8 reactions, or 16.3 per cent. This does not seem to be a significant difference. The normal cases are those which proved to be quite negative from a urological viewpoint, but include some cases whose prostatic secretions were



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not examined microscopically. The pathological cases include almost every condition encountered in urological practice.

The difference between the percentage of reactions due to pyelographic procedures and due to mere ureteral manipulations is not great. There were 251 pyelograms with 52 reactions, or 20.7 per cent., and 77 instances of ureteral manipulations only with 11 reactions, or 14.3 per cent. This seems to indicate that a pyelogram means a slight additional risk in reference to cystoscopy reactions. The fact that the catheters remain in the ureters a longer time may be partly responsible for this, as in our hospital pyelography necessitates the transfer of the patient to a stretcher and to another room.

There are only a few double pyelograms in this group, since it is the present policy to greatly restrict this procedure. Of 12 double pyelograms 5 were followed by reactions, *i.e.*, 41.7 per cent. This not only points to the inadvisability of double pyelograms, but also accentuates the fact previously mentioned that the pyelogram *per se* represents an additional injury.

Of 24 complete cystoscopic examinations on cases with tuberculous kidney lesions only four were followed by a cystoscopy reaction. Many of these cases had genital tuberculosis in addition. The group is small, but it seems nevertheless that bad results must be relatively uncommon in such cases.

When the discrepancy between males and females in incidence of post-cystoscopic reactions became evident, the question of the status of the posterior urethra and of the prostate in reference to cystoscopy reactions was a natural one. Fortunately the male group contained a number of frank chronic prostatitis cases. There must have been many others, since prostatitis is an exceedingly common complication in infections of the urinary tract, but the cases referred to here are only those in which prostatitis was the major pathological condition. Of 18 such cases, 7 showed a temperature rise after cystoscopy. It is unfortunate that this point was not watched more closely from the start, but the high percentage figure of 38.8 per cent. is convincing enough.

The warning not to employ cystoscopy if the patient has a high temperature—let us say over 102 F.—has been ignored twenty-one times in this series. There were no untoward consequences. The temperature elevations were due to diverse causes including pyelonephritis, pyonephrosis, and renal tuberculosis. In pyogenic conditions it has not been an uncommon observation to see the temperature drop after cystoscopy, especially if the affected kidney pelvis had been drained and irrigated.

The group contains two cases with bad results following pyelography. The first case was that of a young male whose chief complaint was pain in the lower abdomen. His urine contained no pus and his temperature was normal. Nothing was found except an abnormally large inferior calyx of the right kidney as seen in the pyelogram. His temperature rose to 104.8 F. during the next day and five days later his right kidney was explored. Multiple cortical abscesses were found; decapsulation was followed by recovery.

The second case was that of a middle-aged male whose chief complaint was pain in the left kidney region. Cystoscopy revealed good function of the right kidney and poor function of the left. Pyelogram showed a deformed pelvis on the left side, which led to the diagnosis of tumor of the left kidney pelvis. The patient developed anuria during the following day which persisted in spite of vigorous medical treatment. He died on the fifth day with uræmic symptoms. The permission for autopsy could not be obtained.

There was also a case in which the ureter was perforated in an attempt to pass an impacted ureteral calculus. The intended pyelogram showed the opaque solution in the peri-ureteral tissue. There were no bad results, not even elevation of temperature or pain.

Reviewing the material presented, it seems to be clear that cystoscopy reactions are due to trauma plus infection. It is quite possible of course that infection *per se* might set up a febrile reaction, but trauma seems to be such a strong contributory factor that it should be given almost equal weight. It seems that the attitude toward infected cases should be the same as toward the non-infected cases; we should strive to prevent additional infections in the former as well as to prevent primary infection in the latter. In view of the fact that most reactions are almost immediate and short-lived bacteriæmias due to organisms being introduced into the blood stream by trauma of the lower urinary tract, it seems to be a highly promising undertaking to attempt the reduction of these organisms to a minimum. Such an attempt is being made now in the Urological Service of Bellevue Hospital, and a report will be published after a large number of cystoscopies have been observed.

The question of trauma should then receive a careful inquiry. Aside from the utmost gentleness and accuracy, no specific advice occurs to us with the exception of Joseph's counsel to use instruments of as small a calibre as will permit the necessary examination.

#### CONCLUSIONS

1. The presence of infectious organisms and trauma are the most important factors in the causation of cystoscopy reactions.
2. Cystoscopy reactions are far more common in men than in women.
3. The skill and gentleness of the operator play an important rôle in the incidence of cystoscopy reactions.
4. Elevated temperature and infection of the urinary tract, with exception of acute prostatitis are not absolute or even common contra-indications to cystoscopy.
5. Cystoscopy should not be undertaken lightly, pyelography is still more serious than simple ureteral catheterization, and double pyelography should be performed only under the pressure of unusual circumstances.

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# THE ABDUCTION TREATMENT, A STANDARD PROCEDURE FOR ALL FORMS OF FRACTURE AT THE HIP-JOINT\*

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IT HAS long since been amply demonstrated by reports from many sources that the result in fracture of the neck of the femur is more directly determined by the efficiency of the treatment than is that of other fracture. Furthermore, that in a comprehensive sense the abduction method is the only

means by which efficient treatment may be applied:

Because it is the only method practicable for elderly and aged patients:

Because it is the only method by which resistant deformity may be definitely corrected.

Because it is the only method by which the security of apposition essential to repair of the transcervical fractures may be assured.

Since, therefore, the method is mechanically adequate, since its effects are physically demonstrable and since it is under single control, it fixes the responsibility for the opportunity for repair and therefore



FIG. 1.—The characteristic attitude of fracture of the neck of the femur.

establishes a standard to which treatment must eventually conform. None of the statements that support this conclusion has ever been questioned by any one qualified by training and experience as a practical critic.

The abduction treatment simply because it is efficient and in accord with that of all other fractures presents a complete contrast to the established teaching and practice. This teaching, which was formulated by Sir Astley Cooper early in the last century, is summarized in a modern treatise on fractures as follows:

“The ideal object of treatment, restoration of form and function, is rarely to be attempted or even sought. The first indication is to save life, the second to get union, the third to correct or diminish displacements.”

The treatment, in theory at least, was to be adapted to the patient and to the character of the injury.

To save life one would disregard the fracture in the interest of the patient.

\* Read before the New York Surgical Society, November 23, 1927.

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FIG. 2.—The first step in the abduction treatment. The shortening is reduced by direct manual traction and verified by measurement, the limb having been rotated slightly inward as indicated by the position of the patella.



FIG. 3.—The second step. The limbs are, under manual traction, abducted to the normal limit as indicated by the range on the sound side, upon a level pelvis, the surgeon verifying the exact correspondence of the two sides.

An intracapsular fracture being incapable of repair, the diagnosis relieved the surgeon from all responsibility for the result.

Extracapsular fractures were regarded as of little therapeutic importance because, in the words of an authority, "they get well anyhow under good or bad treatment."

Deformity, if it assured apposition, must be protected, "for to break up an impaction was a surgical crime."

Although to save life was the first consideration, the death rate has been



FIG. 4.—The after-treatment. Frequent changes of posture prevent bed sores and hypostatic congestion. Note the elevation of the head of the bed, the full extension at the hip and the flexion at the knee.

very high, rising to 63 per cent. in one series of cases, while the functional results have been almost incredibly bad. According to Smith, "no matter whether the fracture is within or external to the capsule, whether it has united by ligament or bone, shortening of the limb and lameness are the inevitable results."

Function, it may be noted, received no consideration either in immediate treatment or after care, or even in the analysis of the final disability. A good result implied simply security in locomotion, and from this standpoint, according to the report of the British committee, the result in but 23 per cent. of the patients actually treated might be classified as satisfactory.

In recent years there has been a reaction from the conventional routine in favor of immediate operative intervention for fractures of intracapsular type.

The most radical of these procedures is that advocated by Koenig (*Zent. f. Chir.*, April 24, 1924). He concludes from anatomical and pathological investigations, that defective nutrition will prevent repair. Consequently in order to forestall failure, he removes the head and fashions the upper extremity of the neck into an oval, weight-bearing extremity.

The more common type of operation is that of bone-pegging, of which the latest exponent is Hey Groves (*Br. J. Surg.*, January, 1927). This in contrast to Koenig's operation is based on the proposition that lack of apposition and not deficiency in blood supply is the cause of failure and that union may be assured by adjusting the fragments and fixing them by a peg of beef bone. The operation is difficult. It is limited in its application to patients of the most favorable class and except in expert hands is either impracticable or of doubtful utility. There is, furthermore, the technical objection, that disintegration of tissue is very common in fractures of this type. This, if not extreme, may not prevent eventual repair if contact persists. If, how-

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ever, a peg had been inserted, the fragments would in this event be held apart by the means designed to appose them.

The third and most conservative of the operations, if it may be classed as such, is Cotton's artificial impaction (*Surg., Gynec. and Obst.*, September, 1927). In his original paper it was stated that a complete intracapsular fracture never united under mechanical treatment, while an impaction assured union. Therefore by inducing a secondary impaction one might reproduce the conditions favorable to repair. This is accomplished, after the fragments have been apposed by manual traction, abduction and inward rotation, by repeated blows with a heavy mallet over the suitably protected trochanter until there is a sensation of something giving way, and evidence of greater security, which indicates a successful impaction. The limb is then fixed by a double plaster spica in extension, abduction and inward rotation for the usual period. As an independent procedure, secondary impaction is open to criticism both on theoretical and practical grounds.

Failure of union, if the opportunity for repair has been assured, is most reasonably explained by lack of nutrition and is usually accompanied by loss of substance. A primary fracture without displacement should interfere but little with blood supply as compared to complete separation of the fragments, and since nutrition can not be improved by further injury, the only merit of secondary impaction must be security of apposition. Cotton states that this is greater than can be obtained by the abduction method, which permits slipping of the fragments. From an extended experience



FIG. 6.—The same fracture three months later, showing the security assured by long contact and progress of repair.



FIG. 5.—Typical transcervical fracture before treatment by the abduction method. (See Fig. 6.)

it may be stated that if displacement occurs it is evidence of the faulty application of the method, since security is assured by bony contact. Full anatomical abduction requires a neck of normal length. If it had been shortened

by the "giving way" incidental to impaction complete abduction would not be practicable and therefore the anatomical fixation would be less secure. The question, therefore, is of the actual physical effect of malleting the trochanter, which in the absence of any evidence other than Röntgen pictures is a matter of conjecture. Indeed, it would seem in view of the small area of the fragments that the giving way might be more reasonably explained by lateral distortion or displacement than direct penetration.

It may be noted that in Doctor Cotton's figure illustrating the plaster spica, the limb is fixed in extension, inward rotation and approximately 30 degrees of abduction. I conclude

from observation that this attitude is fairly representative of the abduction treatment as it is ordinarily applied. Certainly the angle is as great as can be attained in the cases in which no anæsthetic is employed. It seems fair to conclude therefore that Cotton's success may be accepted as further evidence of the inherent capacity of the tissues for repair when opportunity is assured by utilization of the mechanics of the hip-joint.

The most recent and authoritative contribution to the literature from this standpoint is that of Löfberg (*Zeit. f. Chir.*, August 27, 1927), who at a recent meeting of the Northwestern Society of German surgeons presented a large number of patients illustrating the results of the abduction treatment as a routine of hos-



FIG. 7.—A so-called "walking case" of incomplete fracture, showing the outward rotation of the shaft on the neck. A type of deformity that can be corrected only by the abduction method. (See Figs. 8 and 9.)

pital practice. The number of patients treated was 264—88 males, 176 females. Seventy-eight per cent. of the patients were over fifty-five years of age, the youngest seventeen, the oldest ninety-five. One hundred and seventy-two of the fractures were intracapsular. In these cases bony union and good function was attained in 67.5 per cent. Ninety-two were extracapsular, in all of which union and satisfactory function was attained. The death rate was 6 per cent. In the majority of the cases general anæsthesia, practically an essential to complete abduction, was not employed and the period of fixation was but eight weeks. These points were noted in the discussion by Anschütz, who stated that he had obtained union in 90 per cent. of the cases of intracapsular fracture by a more rigorous application of the treatment. If, however, one accepts Löfberg's results as fairly representative, they indicate that Koenig's operation is unjustified, that primary bone-pegging is indicated only in exceptional instances, and that



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artificial impaction, at best a supplement to the abduction treatment is unnecessary when the anatomical splinting has been utilized to best advantage.

It may be noted that these operations represent three divergent interpretations of the old teaching. Cotton is particularly insistent on the therapeutic distinction between the intra- and extracapsular fracture in order to define the scope of artificial impaction as one of five alternatives that in his opinion may be employed with advantage in the treatment of fractures at the hip.

Primary operative treatment, although not of great importance from a numerical standpoint, has been considered at some length because it obscures the main point at issue, which is to establish a standard



FIG. 8.—After forcible reduction illustrating the attitude of the limb. (See Fig. 7.)



FIG. 9.—The final result. Compare with Fig. 7.

of efficiency in the place of standardized neglect. The abduction treatment is the exponent of this reform because it is adequate to apply surgical principles in a comprehensive sense. Thus, being unhampered by the restrictions of conventional teaching the type of fracture is of interest only from the standpoint of prognosis, the two extremes in this regard being the subcapital fracture and the fissured fracture at the base.

Even if the prospect of repair were as dubious as it was once thought to be, one would still apply the abduction treatment in order to protect the patient from exhausting pain, from infected bed sores and the other dangers of persistent dorsal recumbency.

The primary essentials for a standardized treatment are surgeons qualified by training and experience to apply it.

The objections to the abduction treatment, apart from those based on the ancient teaching, as well as the various modifications in its application, may be best explained either by a

misunderstanding of the mechanical principles involved or by lack of training in plaster technic.

It may be emphasized, therefore, that the fixation of the fragments is accomplished by anatomical splinting and that the function of the plaster spica is simply to hold the limb in the attitude that makes the internal splinting effective. Consequently that the close adjustment and compression required for effective support by an external splint are not essential.

The plaster spica is the only form of support at general command and fortunately it is by far the most effective and comfortable of all splints. It is in fact, what may be called its mobile quality that has made efficient treatment practicable for patients of the class in which "the saving of life" was formerly the first consideration. The plaster

FIG. 10.—Fissured fracture at the base. See Fig. 11.

spica is applied in full abduction to assure fixation by bony contact; in full extension to utilize the most resistant part of the capsule and to assure normal lordosis; in slight inward rotation to check the tendency toward the prevailing deformity and to prevent the possible inclusion of the capsule between the fragments. The long spica has the great advantage that the patient may be turned and transported as "one piece" and that movement of the sound limb is not restrained. The thoracic part is of advantage in equalizing the leverage of the abducted limb. It is applied over a thick covering of sheet wadding and need cause no constriction of the chest whatever. If desirable the front may be removed down to the pelvis, leaving the lateral supports, but this is rarely indicated.

Since these advantages in a comprehensive sense can not be assured by any of the numerous modifications that have been suggested, and since what may be termed the orthodox method has stood the test of time, it should be accepted as a standard in future teaching.†

† The application of the abduction treatment is described in full detail in the *ANNALS OF SURGERY* for January, 1925.



FIG. 11.—The fissure closed by forcible abduction.

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Since fracture of the neck of the femur is now treated as an entity the results should be estimated from the same standpoint, for certainly nothing is more firmly established both in the professional and lay mind than that a "broken hip," in an inclusive sense, entails irreparable disability.

In Löfberg's cases 65 per cent. were intracapsular. On the other hand, in 341 cases recently reported by Stebbing (*Br. J. Surg.*, October, 1927) only 111, or 33 per cent., were of this type, yet the average age of the patients, who were inmates of a poor law infirmary, was over sixty-nine years, a period of life at which, according to Sir Astley Cooper, this is the characteristic fracture.

If the two types of fracture be fairly equal in number, and if union may be attained in 67 per cent. of those of the neck proper, and in all of the others, the prognosis for fracture at the hip under efficient treatment will compare favorably with that of other fractures of the lower extremity in patients of the same class.

In a certain proportion of the transcervical fractures, defective nutrition will prevent repair in spite of favorable opportunity. In such cases there is usually an accompanying loss of substance that would embarrass function even if bone-pegging were successful. Consequently, what has been called the reconstruction operation is usually indicated. This consists essentially in providing a new bearing surface by separating the trochanter at its base and transplanting it at a lower level to the outer side of the shaft in order to restore the leverage of the abductor muscles. The head of the femur having been removed the improvised neck is inserted in the acetabulum. (Fig. 12.)

This operation has the great advantage over bone-pegging that security in locomotion, since it is not dependent upon the doubtful capacity for repair, is assured within a definite period.

It will appear, therefore, that with an adequate primary treatment and an effective operation in event of failure, fracture of the neck of the femur may be considered as fairly under surgical control.



FIG. 12.—The reconstruction operation—showing the stability of the improvised neck.

# SUSPENSION OF THE FOOT IN TREATMENT OF POTT'S FRACTURE WITH PERSISTENT POSTERIOR DISLOCATION OF ASTRAGALUS\*

By JOHN C. A. GERSTER, M.D.

OF NEW YORK, N. Y.

POTT's fracture with splitting off of the posterior surface of the tibia had special attention called to it in 1914 by both Cotton,<sup>1</sup> whose name is often used in connection with this type of ankle-joint fracture, and Kellogg



FIG. 1.—Anteroposterior view of fracture of the ankle with persistent posterior dislocation—Cotton's fracture—Speed's lipping fracture.

Speed,<sup>2</sup> who termed it a "lipping" fracture. Speed's figures showed that lipping fracture occurred in at least 10 per cent. of ankle fractures, and that good results, as demonstrated by skiagrams, were not obtained in more than four-sevenths of the cases treated.

Treatment depends on clinical recognition of the condition, immediate reduction under anæsthesia, and enforced dorsal flexion of the foot on the leg. To quote Cotton's most recent statement:<sup>3</sup> "The lesion involves a break of the fibula, at or close to the joint level, a break of the inner malleolus, and a breaking away of the back edge of the tibia. Commonly enough the tibial wedge and the malleolar fragment are broken away in one piece, but even

more often in two separate fragments . . . If the dislocation is reduced, then so are the fractures . . . Once we regard this clearly as a backward deformity of the foot, a lesion corresponding to Pott's, which is an outward luxation . . . we shall do much better . . . There are (other) refinements of reposition . . . and if reduction is carried out with this in mind, we are going to avoid at least some of the calamities attending upon failure of adequate reduction."

In brief, according to Cotton we are dealing with a backward dislocation which can be reduced early and kept locked in forced dorsal flexion.

Regarding after-treatment, Cotton says: "It is that of Pott's fracture save that early mobilization is absolutely essential and no weight should be

\* Read before the Southern Surgical Association, December 13, 1927.

## SUSPENSION OF THE FOOT IN POTT'S FRACTURE

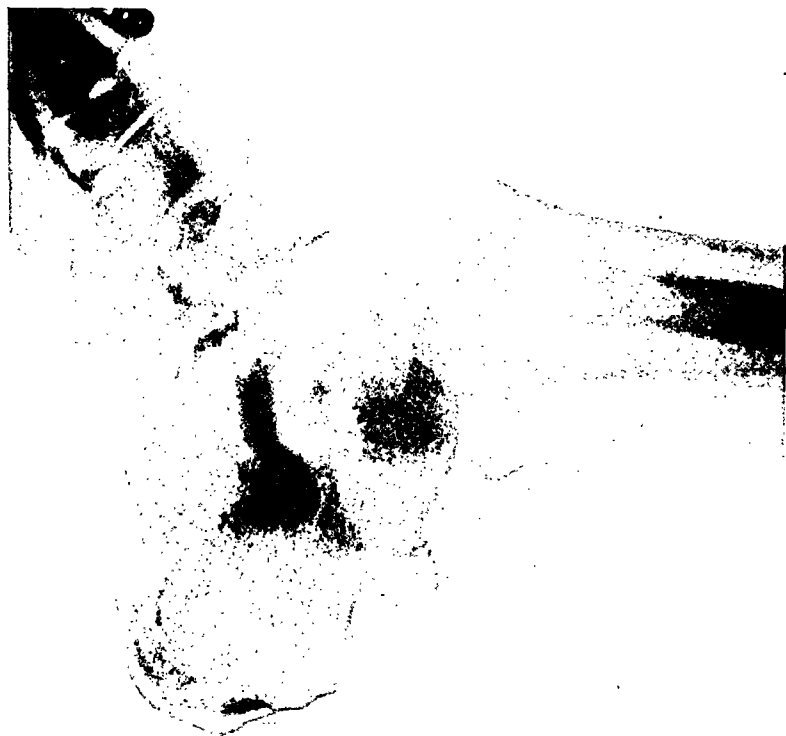


FIG. 2.—Lateral view of fracture of the ankle with persistent posterior dislocation—Cotton's fracture—Speed's slipping fracture.

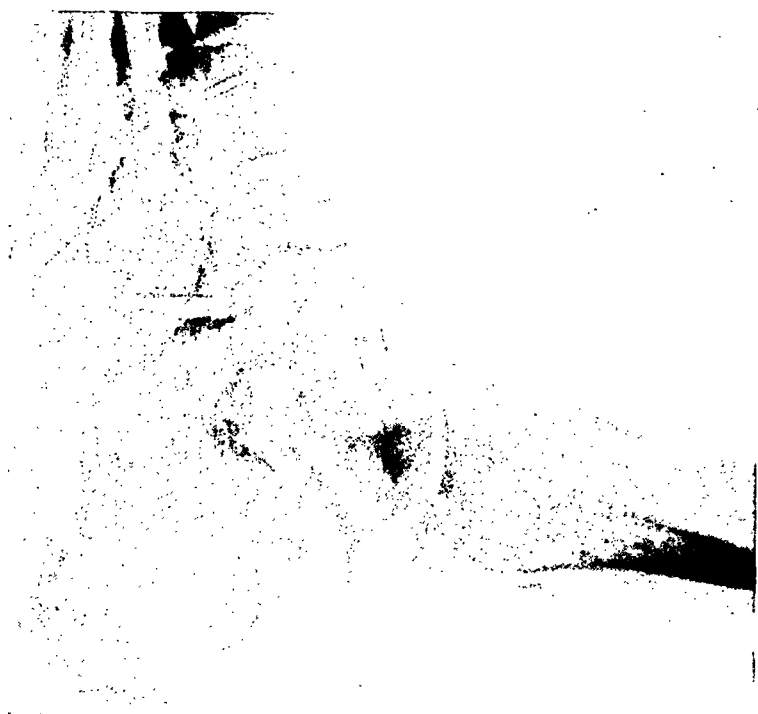


FIG. 3.—One week after injury and two days after suspension of foot.

borne upon the foot for at least seven or eight weeks."<sup>1</sup> During convalescence there is a tendency for the callus to yield and permit a certain amount of recurrent posterior dislocation, as is shown by Cotton's statement that in the after-treatment (after removal of the plaster) protective ambulatory splints should be worn for six or seven weeks, and that these splints should be rigged with a laced leather across the face of the tibia, low down, to guard against forward slipping under weight.

That such manipulative reduction is not invariably possible is shown by Speed's advice to resort to subcutaneous extra-articular nailing where manipu-

lation fails,<sup>2</sup> and by Dowd's report<sup>4</sup> of his resort to a lengthening of the tendon of Achilles in two cases with persistent posterior backward displacement of the tarsus, in order to obtain adequate reduction.

However, Cotton, in closing the discussion of his 1914 paper, said: "With regard to cutting the tendon of Achilles I have done that in tarsal fractures, but I dislike to do it, because a certain amount of atrophy is caused and it takes a while for the function to come back. . . . Another reason why I dislike to do this cutting is that in putting the cases up in dorsal flexion, it is the Achilles tendon that is depended on. Some cases can not be treated without open operation, which is undesirable."

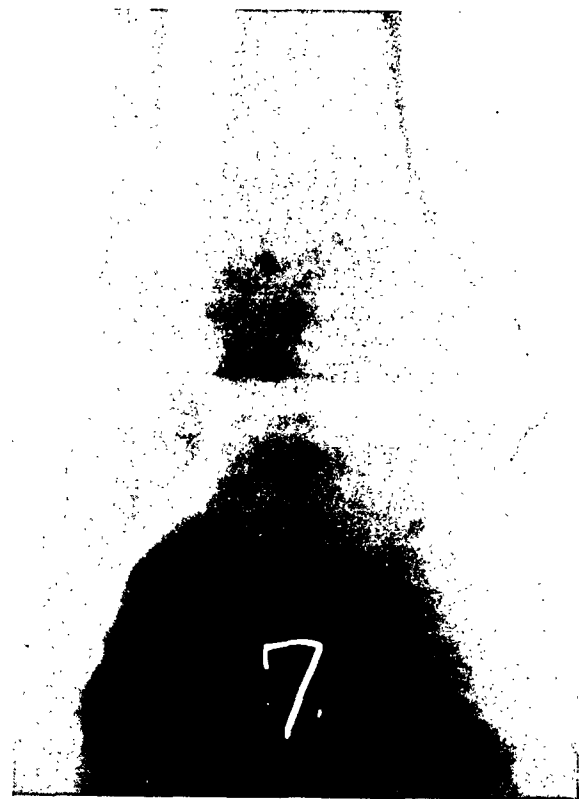


FIG. 4.—One week after injury and two days after suspension of foot. Anteroposterior view.

Wilson and Cochran<sup>5</sup> advise Z-shaped tenotomy of the tendon of Achilles or application of continuous traction to the foot, with the comment that "tenotomy in adults often leads of itself to considerable disability and the traction method is preferable, namely, a metal pin<sup>†</sup> over the os calcis in conjunction with a Thomas splint, using 15 to 25 pounds at first." They also mention operative reduction.

Roberts and Kelly suggest the use of traction by a Sinclair skate (plantar foot board) and adhesive plaster with pulley extension. Steinmann's nail traction from the heel may be used also.<sup>†</sup> They advise that weight bearing

<sup>†</sup> To digress for a moment, the author would strongly advise against resorting to a Steinmann pin or other form of skeletal traction, as advised by some writers, as the parts invariably show extensive ecchymoses and Steinmann in his original paper expressly states that the pin must not pass through the "fracture hematoma" because of the dangers of infection.

## SUSPENSION OF THE FOOT IN POTT'S FRACTURE

be postponed for from ten to fifteen weeks in severe cases and then very cautiously permitted.

Kellogg Speed<sup>6</sup> also advocates nailing of fragments in correct position through a small skin opening.

In a recent case of the writer's, a stout, plethoric, middle-aged, alcoholic man, with this type of fracture, presented such an extensive ecchymosis and swelling of the ankle and leg that any operative interference would have been fraught with the gravest danger to both limb and life. Two attempts at plaster-of-Paris immobilization under general anæsthesia were unsuccessful; then simple maintenance of the foot in elevation was found to produce entirely effective reduction, the weight of the leg being sufficient to carry the lower end of the tibia backward into its normal position. Active flexion and extension of the ankle was practiced almost from the first—an additional advantage over plaster-of-Paris immobilization. Hyperextension of the knee was prevented by suitably adjusted support.

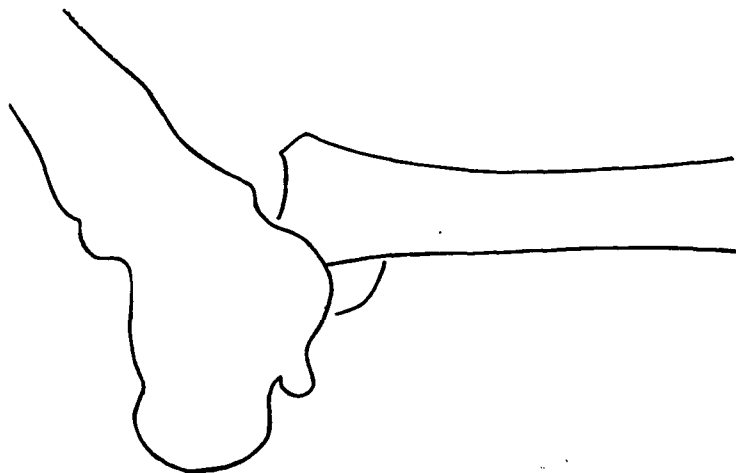


FIG. 5a.—Tracing of Fig. 2, to be compared with Fig. 10.

Henry DeF., aged sixty-two, sustained a Pott's fracture of the left ankle, February 17, 1924, and was admitted to the Lenox Hill Hospital, service of Dr. DeWitt

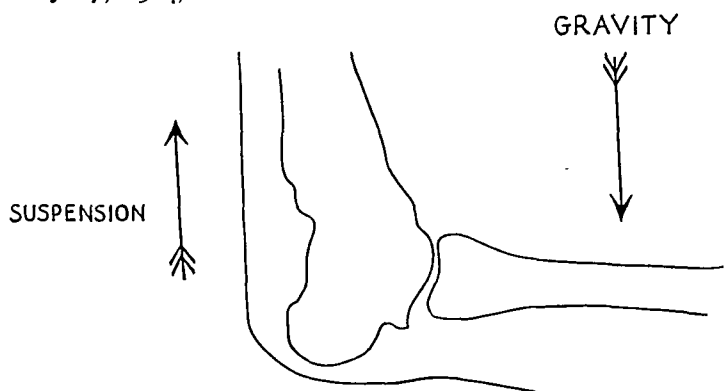


FIG. 5b.—Tracing of Fig. 6, showing effect of opposing forces of suspension and gravity in maintaining reduction and permitting active motion.

Stetten. There was extreme ecchymosis and swelling involving the ankle and lower half of the left leg. X-ray revealed fracture of both internal and external malleoli, together with a chipping-off of the posterior articular lip of the lower end of the tibia. (Figs. 1 and 2.) Two successive attempts at reduction in plaster-of-Paris (February

18 and 20, respectively) were unsuccessful. February 22, suspension of the foot by means of adhesive plaster applied to the sole and posterior aspect of the heel<sup>‡</sup> produced

<sup>‡</sup>I have since had several cases in which simple suspension of the foot on the orthopædic table, allowing the weight of the unsupported leg to have its constant effect during manipulation of ankle fractures, without anæsthesia, facilitated manipulative replacement of fragments and the subsequent application of plaster splints.

Cotton<sup>8</sup> (Dislocation and Joint Fractures), in discussing fractures of both bones of the leg just above the ankle-joint, shows (Fig. 1036c, page 569) a sling of adhesive plaster for supporting the foot when using a posterior splint, evidently to prevent anterior angulation of the fragments.

an effective reduction. (Figs. 3 and 4.) The foot being elevated and fixed, the natural weight of the leg was sufficient to maintain reduction. Properly adjusted suspension under the knee-joint prevented hyperextension and yet did not interfere with maintenance of reduction at the ankle. At first, slight traction (five pounds) to the foot by means of a Sinclair skate was instituted. This proved to be superfluous and was discontinued after three days. X-rays taken on March 25 showed that reduction was maintained. During all this time free active dorsal and plantar flexion of the ankle was practiced. Suspension for five weeks was followed by physiotherapy for three weeks more. The patient was discharged on April 16, 1924.

During the first week of hospitalization there was some fever, but this subsided. The patient was seen and examined three years later. There was no disability and he had good function. Figures 5, a and b, illustrate the mechanics involved.

From the foregoing we consider that this method, which maintains reduction and at the same time permits voluntary motion, possesses sufficient merit to be borne in mind and to be tried in severe types before resorting to Cotton's method of plaster immobilization or to operative reduction.

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# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

*Stated Meeting Held November 23, 1927*

The President, DR. FRANK S. MATHEWS, in the Chair

### RUPTURED POPLITEAL ANEURISM. ENDO-ANEURISMORRHAPHY RECONSTRUCTIVE TYPE

DR. ALFRED STILLMAN presented a man, thirty-seven years old, colored, who noticed five weeks before admission to Roosevelt Hospital, August 3, 1927, a small lump behind his right knee. The lump was not painful, but it had gradually grown larger and interfered with walking. Examination showed a swelling of the entire popliteal space, not tender but hot and semi-fluctuant. It looked like an abscess. There was no thrill felt or murmur heard over it and there was no expansile pulsation. The dorsalis pedis pulse was absent. Aspiration of the tumor obtained bright blood. His Wassermann returned four plus.

August 9, 1927, a tourniquet was applied and an incision six inches long was made down the middle of the popliteal space. On incising the deep fascia, clots extruded. These were wiped out until a cavity presented with smooth shining walls and at the bottom a groove about three inches long connecting two orifices. With a vaselined silk stitch, starting proximal to the upper opening and ending distal to the lower, the edges of this groove were approximated. The tourniquet was loosened and a little bleeding occurred, soon stopped by one or two more stitches when the tourniquet was entirely removed. A second row burying the first was then applied and the wound closed with a rubber tissue drain. The cavity seemed too big and the skin too tight for closure in the method suggested by Matas. The dorsalis pulse was immediately felt and has continued present ever since. The patient made an uneventful recovery and was discharged September 6.

Matas says the obliterative operation is the simplest, most conservative and safest of the radical operations for the cure of aneurisms of the extremities. Since he has learned by increasing experience how to determine the efficiency or inefficiency of the collaterals by four practical and dependable tests, namely: (1) The hyperæmia reaction or modified Moszkowicz color tests; (2) the preliminary occlusion of the main artery close to the proximal pole of the sac with pliable and removable bands; (3) oscillometric manometer, to determine the peripheral blood-pressure after temporary occlusion of the main artery, and lastly (4) the clinical evidence of a persistent circulation and nutrition of the peripheral parts in spite of the permanent absence of the peripheral pulses, he finds the indications for the reconstructive operation less frequent.

In reporting October 28, 1926, 478 operations, he said 80 per cent. were of the obliterative type and 20 per cent. of the reconstructive or restorative. Deaths directly attributed to the operation (apart from the aortic) do not exceed 4.5 per cent., the gangrenes 3.5 per cent., secondary hemorrhages 1.6 per cent., and relapses in less than 1 per cent.

## SPONTANEOUS HEALING OF OSTEOMYELITIS

DR. RICHARD LEWISOHN presented a boy three years old who, when first seen in the Dispensary of Mount Sinai Hospital on July 15, 1927, gave the following history: Simultaneously with an attack of scarlet fever thirteen weeks ago the left leg began to swell from ankle to knee. He was in another hospital for four weeks, where a small subcutaneous abscess in front of the tibia was aspirated and a few drops of pus were obtained. His temperature was slightly elevated, ranging between 99 and 100°. The left leg showed a slight thickening anteriorly. There was some tenderness on pressure on the anterior aspect of the tibia. The Wassermann reaction was negative. X-ray examination (Fig. 1) showed a destructive process involving the lower half of the tibia. The boy was subsequently admitted to the hospital. An X-ray picture taken August 16 showed about the same findings as those reported July 15. Under expectant treatment this process cleared up gradually and the boy was discharged from the hospital September 16. An X-ray examination taken recently (November, 1927) shows a normal tibia. (Fig. 2.)

DOCTOR LEWISOHN presented this boy in order to show that in rare instances an osteomyelitis can heal completely without surgical interference and without formation of a sequestrum.

DR. MORRIS K. SMITH showed three radiographs in connection with Doctor Lewisohn's case and said that the patient, a boy of nineteen, applied at the dispensary of St. Luke's Hospital in May, 1926. He had been ill for a month and had spent part of this time in bed. He described his illness as influenza followed by rheumatism. When he presented himself the right arm was swollen, the humerus felt thickened and was somewhat tender. There was no point of fluctuation and no marked redness. The first picture was taken in May, 1926, when he was first seen. He was afebrile and not suffering pain. He was followed for a month after which he disappeared from view. He finally showed up in January, 1927, about eight months after the first radiograph and at this time his arm was clinically well. He had done rather strenuous exercise with the arm. The last picture taken showed the bone healed except for one small area, which, however, at some time may result in an abscess.

DR. WALTER M. BRICKNER remarked that the text-books say very little concerning spontaneous recovery of acute osteomyelitis, but the literature is not entirely silent on the subject. He himself had referred to such spontaneous cures about twenty years ago in "Surgical Suggestions". A few years ago Frazier, of Edinburgh, expressed the opinion that acute osteomyelitis in children that subsides spontaneously is almost invariably a pneumococcus infection. The speaker had seen a few cases of spontaneous subsidence of acute osteomyelitis in children and he had also seen two cases in adults in which a post-traumatic, localized, acute osteomyelitis went on to spontaneous recovery. In one of these cases an osteomyelitis of the lower end of the radius was followed by an eventually fatal septic endocarditis. The local signs had completely disappeared and when the bone was explored a few weeks after the onset nothing was found.

DR. HOWARD LILIENTHAL said that in cases of acute septic osteomyelitis

# SPONTANEOUS HEALING OF OSTEOMYELITIS

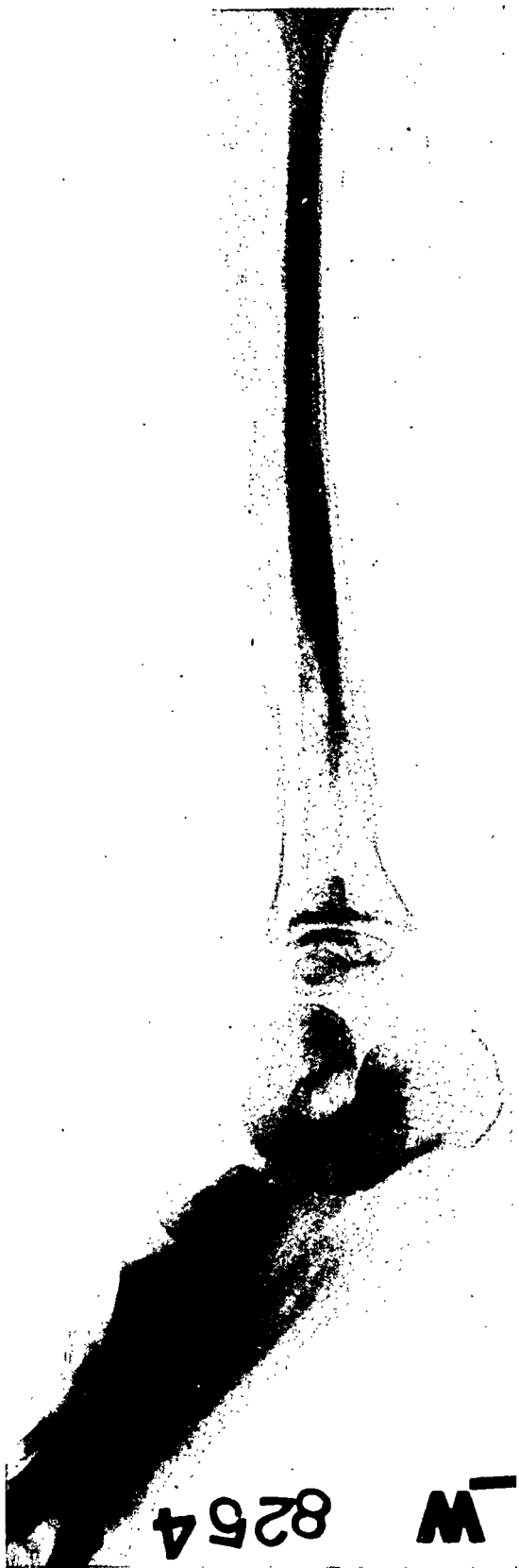


FIG. 1.—Osteomyelitis of tibia.

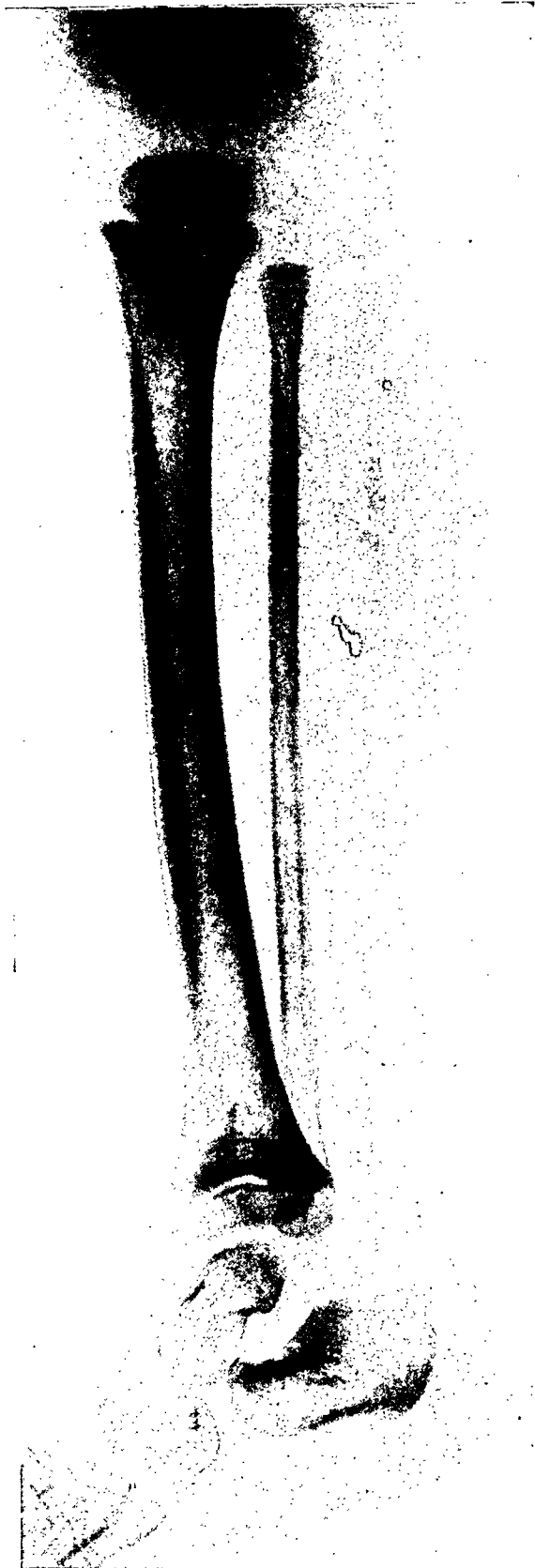


FIG. 2.—Recovery from osteomyelitis; same tibia as shown in Fig. 1, six months later.

surgery is certainly required for the relief of tension. In the more chronic cases X-ray examinations may point the way to the proper surgical procedure such as the removal of sequestra. In the main the subject resolves itself into two headings: (1) That the septic cases require some form of drainage, and (2) that the more chronic ones should be observed and that local retention should be relieved. Before the days of Röntgen, exploratory operations were distinctly more frequent than they are at present.

#### THROMBOCYTOPENIC PURPURA—SPLENECTOMY

DR. RICHARD LEWISOHN presented a boy, fifteen years old, who was admitted to Mount Sinai Hospital, December 21, 1925. He gave the following history: Following a tonsillectomy performed three years ago in the dispensary the boy had three profuse hemorrhages, requiring hospitalization for one week. During the last two years he has suffered from epistaxis every month which lasted for about one week. A tooth extraction two years ago was followed by bleeding over a period of twelve hours.

The status was essentially negative. Liver and spleen were not palpable. There were numerous ecchymotic spots on the legs. Blood examination (Doctor Rosenthal) presented the following findings:

Hæmoglobin, 83 per cent.	Polymorphonuclear neutrophiles, 68 per cent.
Red blood-cells, 5,400,000.	Polymorphonuclear eosinophiles, 2 per cent.
Color index, 0.7.	Lymphocytes, 27 per cent.
White blood-cells, 14,500.	Chyelocytes, 3 per cent.
Platelets, 52,000.	

Bleeding time three and a half minutes; no clot retraction within twenty-four hours. Coagulation time five and a half minutes. Tourniquet test negative within five minutes.

On the day following the admission several petechiæ were noticed on the lips and in the mouth.

December 25 he bled freely from the buccal mucous membranes. Many petechiæ were observed on the soft and the hard palate.

January 4 the stool contained blood.

Splenectomy was performed January 16 through a left subcostal incision. The abdominal wound was sutured in layers. A rubber tube was placed into the posterior angle of the wound. The patient was severely shocked following the operation, but improved rapidly after twelve hours. He developed a crop of petechiæ on the chest and the right eyelids following the operation, which faded after a few days. He showed severe secondary post-operative anæmia a few days after the operation.

He has been in perfect condition since he left the hospital.

The blood picture (taken November 18, 1927) presents the following findings:

Hæmoglobin, 85 per cent.	Lymphocytes, 46 per cent.
Red cells, 4,800,000.	Monocytes, 8 per cent.
White cells, 7800.	Coagulation time, ten minutes.
Platelets, 140,000.	Bleeding time, one minute.
Polymorphonuclear neutrophiles, 42 per cent.	Tourniquet test, negative.
Polymorphonuclear eosinophiles, 4 per cent.	Clot retraction, normal.

The blood platelets are still slightly diminished. The rest of the blood picture is normal.

DR. EDWIN BEER called attention to the fact that Doctor Lewisohn's patient did not conform to the usual type of thrombocytopenic purpura in

## HÆMOLYTIC ICTERUS—SPLENECTOMY

view of the bleeding time being only three and a half minutes. Duke some years ago emphasized the fact that in this type of purpura the bleeding time is usually prolonged. In some cases, after a slight prick of the finger or ear the bleeding continues for forty or fifty minutes; and even then has to be stopped by compression.

At a recent meeting of the Bellevue Alumni Association, in which the speaker took part in the discussion on surgery of the spleen, he was able to report for the staff of Mount Sinai Hospital, 25 splenectomies for thrombocytopenic purpura, 22 being done in chronic and subacute cases and 3 for acute purpura. Of the former, all but one were saved; whereas of the latter, all died. These chronic cases are apparently very strikingly improved by splenectomy, if not absolutely cured. Some of the cases operated upon by the Mount Sinai Hospital staff have already run six years in perfect health.

## HÆMOLYTIC ICTERUS—SPLENECTOMY

DR. RICHARD LEWISOHN presented a woman, forty-two years old, who was admitted to Mount Sinai Hospital, September 24, 1926. She had complained of general weakness and swelling of her legs during the last five years. She had lost 16 pounds in two years. Her hæmoglobin, taken one year ago, was 45 per cent. It had fallen to 30 per cent. recently. There was no bleeding from the mucous membranes.

She was a rather stout woman with a yellow color of her skin. The conjunctivæ were slightly icteric. No petechiæ. The spleen was markedly enlarged, reaching down to the crest of the ileum and extending over to the median line. The notch of the spleen was palpable. The liver was palpable on deep inspiration.

Examination of the blood (by Doctor Rosenthal) showed:

Hæmoglobin, 32 per cent.	Polymorphonuclear neutrophiles, 75.5 per cent.
Red blood-cells, 2,672,000.	Lymphocytes, 20 per cent.
White blood-cells, 3,400.	Reticulocytes, 8 per cent.
Platelets, 80,000.	Monocytes, 4.5 per cent.

The fragility test showed an increased fragility of the red blood-cells. The Van den Bergh test presented the following:

Direct: negative. Indirect: 1:83000. 1, 2 mg. per 100 cm. The urine was negative for bile. Urobilin was present; 24-hour specimen: 54 mgms. The blood chemistry was normal for the nitrogenous bodies.

The stomach contents showed an anacidity (free acid, 0, total acidity, 35).

The liver function test showed no evidence of liver damage.

DOCTOR ROSENTHAL'S conclusions were: The secondary anæmia, the increased fragility of the red blood-cells and the increase in the reticulated red cells suggest a hæmolytic icterus. The low platelet count makes the prognosis better, if a splenectomy is performed.

Two pre-operative transfusions of 500 c.cm. of citrated blood were given to the patient October 7 and October 10 and the hæmoglobin was raised from 32 per cent. to 60 per cent.

October 15 a splenectomy was performed through a left subcostal incision. The abdominal wound was closed in layers and one tube was placed into the subphrenic space.

The patient made an uneventful recovery. She is perfectly well at present.

The blood examination (November 14, 1927) shows:

Hæmoglobin, 85 per cent.  
Red cells, 6,300,000.  
White cells, 8600.  
Platelets, 510,000.

Polymorphonuclear neutrophils, 59 per cent.  
Lymphocytes, 32 per cent.  
Monocytes, 9 per cent.

Fragility of red cells: No hæmolysis, 0.8 per cent. to 0.6 per cent.; partial hæmolysis, 0.58 per cent. to 0.38 per cent.; complete hæmolysis, 0.36 per cent. to 0.2 per cent.

The fragility of the red cells is unchanged. The blood is otherwise normal.

### CARCINOMA OF THE CYSTIC DUCT

DR. RICHARD LEWISOHN presented a woman, forty-two years old, who was admitted to the Mount Sinai Hospital, November 3, 1926. About six months ago the patient noticed a mass in the right upper quadrant, which has gradually increased in size. The mass was always movable. She has complained of belching and occasional vomiting. She has lost 15 pounds during the last six months.

Examination revealed a large, ballotable mass in the right upper quadrant, reaching below the level of the umbilicus. Differential diagnosis rested between a very large, distended gall-

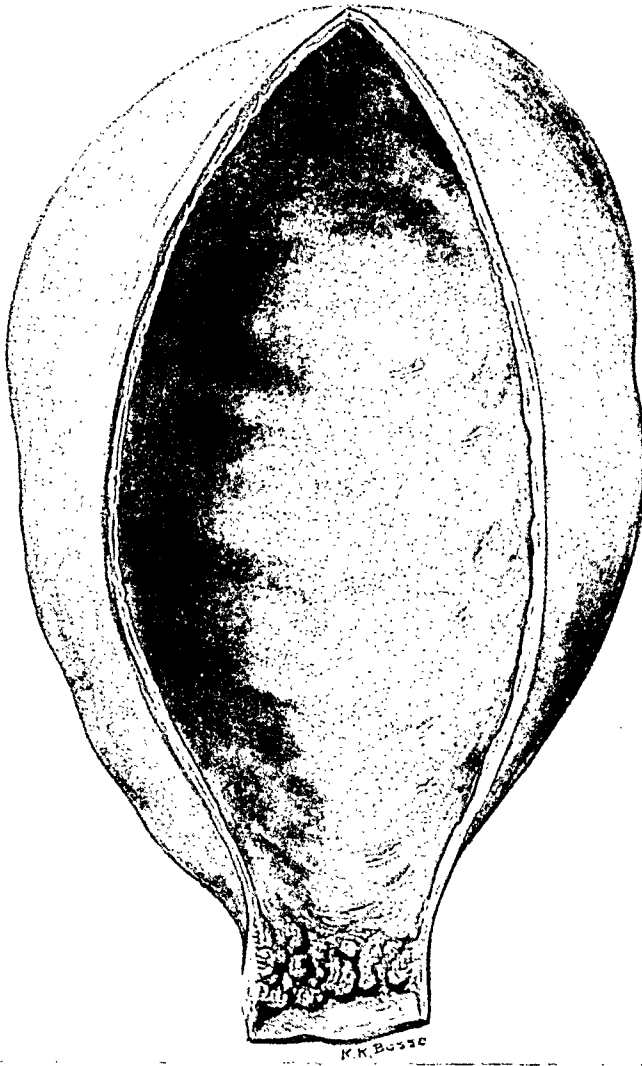


FIG. 3.—Carcinoma of the cystic duct.

bladder and a hydronephrosis. Cystoscopy did not reveal a very marked difference between the function of the right and the left kidney. The pyelogram showed no abnormality. X-ray of the gastro-intestinal tract failed to show any abnormality.

Pre-operative diagnosis: Hydrops of gall-bladder, due to a stone in the cystic duct.

November 16, in local anæsthesia, the abdomen was opened through a right upper rectus incision. A very large gall-bladder presented itself which had the size of a pear. The gall-bladder was aspirated, its contents were white. A mass was felt in the cystic duct. A typical cholecystectomy was performed. The resected specimen showed that we were dealing with a tumor of the cystic duct. The line of dissection had not gone quite beyond

## MULTIPLE COMPLICATIONS FOLLOWING APPENDICECTOMY

the tumor. Therefore the cystic duct was freed for another one-half inch to the level of its entrance into the common duct. Thus the dissection could be performed in healthy tissue. The base of the cystic duct was tied. The gall-bladder did not contain stones. No metastases were noted in the liver or in Winslow's foramen. The abdomen was closed in layers, after a tube and a small packing had been placed in the abdomen.

The pathological report showed present an early adenocarcinoma of the cystic duct with invasion of the gall-bladder wall. The patient made an uneventful recovery and has gained ten pounds since the operation.

## MULTIPLE COMPLICATIONS FOLLOWING APPENDICECTOMY

DR. DEWITT STETTEN presented a girl, ten and one-half years of age, who was operated on at the Fifth Avenue Hospital, January 27, 1925, for a ruptured appendix. The wound was closed without drainage, but was subsequently reopened and drains were inserted. Two days after operation a bilateral pneumonia developed, followed by a left-sided, upper, anterior empyema, for which a simple thoracotomy was done on March 9, 1925. The appendix wound gradually healed, but the empyema wound continued to drain with intervals of closure until March 18, 1925, when the reporter saw the patient for the first time. She then complained of cramp-like abdominal pains to the left of the umbilicus, associated with vomiting. The child was very much emaciated. There was a solidly healed transverse scar in the right lower abdomen with no evidence of hernia. There was some sensitiveness and slight rigidity around the umbilical region, but no visible peristalsis nor palpable enterospasm. There was a small scar of an old empyema wound in the left fifth interspace at the anterior axillary line, with a slight purulent discharge from the posterior portion of this scar. There was some dulness over the left chest posteriorly with diminished voice and breathing. The temperature was slightly subnormal, and the pulse 120. The patient was vomiting. She was immediately referred to the Lenox Hill Hospital. After admission her vomiting and cramps ceased. May 23, the patient again began complaining of cramp-like abdominal pains, and again began to vomit. This vomiting continued, and May 25 the patient was operated on by Dr. P. K. Sauer, with a diagnosis of acute ileus due to post-operative peritoneal bands. A median incision was made and a definite band constricting a loop of ileum near the ileocaecal region with several other bands binding down loops of ileum were found. The definite constricting band was divided between ligatures and excised, and the other bands were also cut and excised. The abdominal wall was closed in the usual fashion. The following day the patient seemed much improved with only slight pain and vomiting. May 27, the patient again began to vomit, and on May 28, the vomiting having continued with cramp-like pains around the umbilicus, the patient was reoperated on by Doctor Stetten with a reopening of the recent abdominal wound, and a slight extension upward of the incision. There was a loop of ileum found tied down by a definite fibrous band in the ileocaecal region. Numerous other loops were found bound down, kinked and adherent to the pelvis. The omentum was adherent to the anterior abdominal wall to the left of the recent incision. After separation of the omentum from the anterior abdominal wall, and resection of portions of it, the fibrous band constricting the loop of ileum was divided and the constriction released. The other bands binding down and kinking the loops of ileum in the pelvis were separated, and the abdomen was closed in the usual fashion. The patient stood the operation remarkably well considering her exhausted condition, and the vomiting ceased within twenty-four hours. The convalescence from the abdominal condition was

uneventful, with primary union of the larger portion of the wound, except for a small granulating area around the umbilicus. The empyema wound, which had healed, reopened with a considerable discharge of pus, and X-ray examination, including injection, showed a fistula running toward the apex of the chest. June 22, 1925, a thoracoplasty was done by extension of incision upward from the fistulous opening, and resection of two inches each of the fourth, third and second ribs. A large empyema cavity beneath these ribs was opened, which contained at least six ounces of thick greenish pus. The anterior wall of this cavity, made up of dense scar tissue, almost cartilaginous in consistency, was resected after the usual ligation of the intercostal vessels. The cavity, of which the upper portion corresponded almost to the apex of the thorax, was kept widely open by gauze tamponade. Thereafter the patient's convalescence was uneventful. She was finally discharged from the hospital on September 2, 1925, with the abdominal wound closed and the thoracic wound almost healed. Her weight was 51 pounds. A moderate herniation of the centre of the median abdominal, and of the outer angle of the lateral abdominal incision has developed. Aside from this the patient has remained perfectly well and her weight on discharge from the hospital has been doubled.

The case is presented as an example of extreme endurance and of unusual toleration to a succession of insults to the organism.

DR. FREDERIC W. BANCROFT said he had seen a similar case. The patient had an acute appendicitis, then a pelvic abscess which was drained; then she had a collection in the left lumbar gutter which was drained, a subphrenic abscess on the left side also drained, followed by empyema on the left side also drained. This patient is now well as far as is known.

#### RESECTION AND RECONSTRUCTIVE ARTERIORRHAPHY FOR BRACHIAL ARTERIOVENOUS ANEURISM

DR. DEWITT STETTEN presented a woman, age thirty-three years, first seen May 31, 1927, with a history of having been stabbed in the right cubital fossa May 7. There was profuse bleeding from the wound, which was sutured in the Beekman Street Hospital. The wound healed by primary union, but some difficulty in extending the arm persisted. The patient held the arm in a slightly flexed position. In the right cubital fossa, just below the three-quarter inch, healed, transverse scar, was a slight, tense swelling, with a distinct expansile pulsation and a definite thrill transmitted downward. On auscultation a loud roaring bruit was heard, also transmitted downward. There was slight limitation to extension of the elbow, but flexion was almost normal. There was no swelling or cyanosis in the forearm, nor were any dilated veins noted. The radial and ulnar pulse could barely be felt at the right wrist, but both radial and ulnar pulse could be distinctly felt at the left wrist. The patient was referred to the Lenox Hill Hospital, and on June 6, 1927, she was operated on by Doctor Stetten with a diagnosis of traumatic aneurism, possibly arteriovenous, of the right brachial vessels. Under an Esmarch bandage applied to the arm, a longitudinal incision was made over the tumor. The bicipital fascia was divided and a thin aneurismal sac, about the size of a small walnut, was exposed. The sac was moderately adherent to the surrounding structures, particularly to the brachialis anticus and the pronator radii teres muscles, from which it was carefully separated. The median nerve was exposed but not injured during the dissection, and retracted inward. Two rather small veins were found to run from the upper pole and two rather dilated veins ran into the lower pole of the aneurismal



## RESECTION AND RECONSTRUCTIVE ARTERIORRHAPHY

sac. The sac was seen to spring from a rather small brachial artery, about one-half inch above its bifurcation into the radial and ulnar. The two small veins running from the upper pole of the sac were doubly ligated and divided. The sac was opened and a small, partially organized, reddish-brown thrombus was removed. The openings of the two dilated veins entering the lower pole of the sac were now distinctly seen, as was also the slit in the brachial artery with the proximal and distal openings of the vessel. Venous blood was seen to enter this sac through vein openings when the veins were not clamped. The dilated veins entering the lower part of the sac were doubly ligated and divided and the sac was then resected, leaving a sufficient flap of sac wall at the slit in the brachial artery for a satisfactory arterial suture. Arteriorrhaphy was now done with a double suture of fine silk. (Fig. 4.) The Esmarch bandage was apparently never completely successful, as Carrel clamps were required to control the arterial bleeding during the arterial suture. After the suture of the artery the Esmarch bandage was removed,

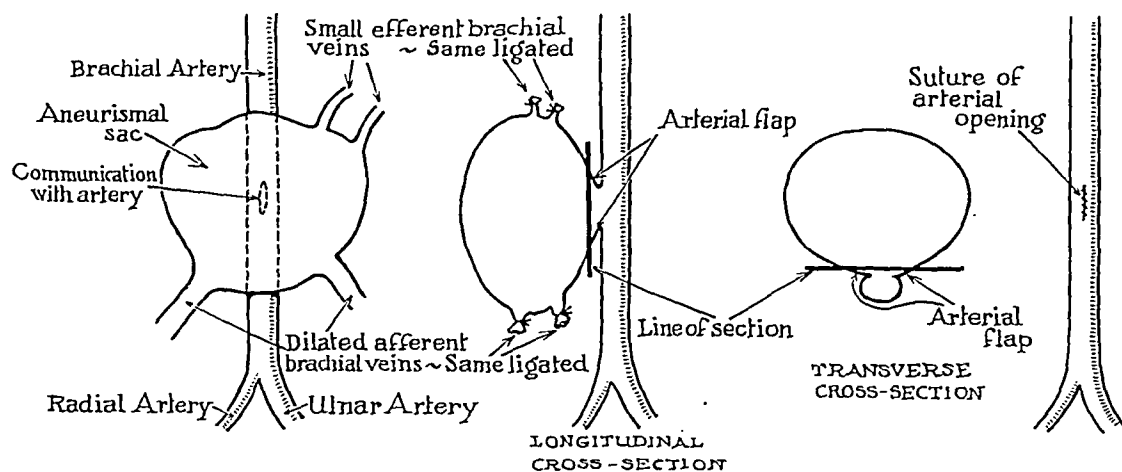


FIG. 4.—Resection and reconstructive arteriorrhaphy for brachial arteriovenous aneurism.

after having been in place about fifty minutes. Distinct pulsation was noted above and below the arterial suture, and there was no oozing at the suture line. The bicipital fascia and skin were then sutured. A firm bandage was applied with an anterior splint holding the elbow in extension. The radial pulse could be distinctly felt after the operation. The wound healed by primary union, but after the operation the patient was absolutely unable to actively move her fingers or her wrist. There also appeared to be some weakness in the biceps, triceps and supinator longus muscles, but there was no disturbance of the sensation in the distribution of the median, ulnar, or musculospiral nerves. All the muscles of the forearm responded actively to Faradism, but possibly a little less than on the left side. The biceps, triceps, ulnar and radial reflexes were all absent. On the left side these were all present and equal. The radial pulse remained distinctly perceptible and the thrill and bruit in the cubital fossa had disappeared. The patient was given daily Faradism, massage and passive motion, and a cock-up, molded, plaster-of-Paris splint was applied to the forearm and hand. About three weeks after operation patient began to move her wrist and fingers. This rapidly improved, and on August 20, 1927, patient was discharged from the hospital with good motion in the elbow, wrist and fingers. Her condition at present is most satisfactory. There is perfect motion in the elbow-joint and perfect function in the right forearm and hand, with excellent grasping power of the hand and no muscular atrophy. No thrill can be felt and no bruit heard in the cubital fossa, and there is a fair radial and ulnar pulse,

almost as good as on the left side. Examination with the Pachon oscillo-meter at the midforearm shows, right: blood-pressure 120, oscillations 1; left: blood-pressure 120, oscillations one and a half.

The case is presented primarily to show the relative simplicity of resecting an arteriovenous aneurism with preservation of the arterial blood supply, and without ligation of the main arterial trunk. The case also demonstrates the menace of the Esmarch bandage as a possible cause of an ischæmic paralysis.

DR. HUGH AUCHINCLOSS said that there is a question as to whether the tourniquet on the arm was the cause of the temporary paralysis in this case. It brings up an interesting subject. The opinion is largely held that a tourniquet should be allowed to stay on only a certain length of time. Some say it should be left on a few minutes, loosened, and put on again. He did not believe the question of time has very much to do with it. Over fifteen years ago he operated on a hand for four hours, with the tourniquet not released at all. The patient had no ill effects whatever. He recently operated on a patient with the tourniquet on for well over three hours and several times had operated with a tourniquet on for over two hours. He should like to emphasize the fact that it is not the length of time the tourniquet is on the arm, nor the shutting off of circulation that matters anything like as much as the way in which it is applied.

The tissues are capable of a certain amount of resistance to pressure. If pressure be made over a broad area, the resistance offered by the tissues is of course very much greater than when pressure is exerted over a very small area. It would be far easier to break the skin and cut through the tissues by twisting a wire than by pulling a broad bandage as tight as one could. If one places at least two, often three, towels, that have been folded longitudinally several times, around the arm so as to make a broad pad and outside that pad wind an Esmarch bandage, it is possible to operate for long periods of time without causing an ischæmic paralysis. It is peculiarly adaptable for operating on osteomyelitis cases. It has been possible to operate on suppurative osteomyelitis of the tibia or fibula without clamping any blood-vessels throughout, with practically no loss of blood. Apply the dressings, elevate the leg, and have less post-operative bleeding and absorption than when the tourniquet has been left off. Far more care should be taken not to severely crush the tissues by a tourniquet. A tourniquet that crushes tissues severely may cause an ischæmic paralysis in a short time, whereas one applied without crushing may be left on for longer than is generally conceded.

DR. HOWARD LILIENTHAL said that much depends upon the location chosen for the tourniquet. Towels or pads are invaluable to place over the limb and the elastic tourniquet applied over them. In making constriction above the elbow special care should be taken since nerve disturbance is common following the use of the tourniquet here. Nerve disturbance never follows elastic constriction over the forearm.

To illustrate a curious freak of hysteria, Doctor Lilienthal recalled the case of a girl of seventeen from whose forearm he removed a neurofibroma

many years ago, using a tourniquet around the upper arm. There followed a complete loss of sensation of the left hand and arm. The anæsthesia gradually spread over the entire left half of her body from the head down. She was unable to use the hand at all, and the member became soft, moist and like that of an infant.

A test of vision revealed the characteristic contraction of the visual field for red. After nearly a year this girl was admitted to a home for chronic invalids. She came to Doctor Lilienthal's office twice a week and feeling certain that she would one day recover, he impressed upon her that there would probably be a sudden return of function, and one day his prediction was justified and she remained well for years afterward. He had not seen her recently. The anæsthesia had persisted for more than a year and a half.

DOCTOR STETTEN said that the paralysis was obviously not due to a direct nerve injury from compression by the Esmarch bandage. He made this statement because there was absolutely no trace of sensory disturbance and because there was a total, unselected paralysis of all the muscles of the forearm and hand, with no interference in the Faradic response. If the paralysis was ischæmic in character, it was because of a direct muscular ischæmia with subsequent muscular degeneration, but this seems rather improbable, as the Esmarch bandage was only on for fifty minutes and never produced a complete hæmostasis. The veins when they were not clamped bled into the aneurismal sac and after the sac was resected the artery bled so much that it was necessary to apply Carrel clamps above and below the opening in the artery, while the arterial suture was being inserted. He was inclined to believe that they were dealing with an hysterical paralysis, an opinion confirmed, in spite of the apparent loss of reflexes, by the rather abrupt, complete recovery, without any atrophy whatsoever.

#### INTRAPERITONEAL RUPTURE OF URINARY BLADDER DURING ABDOMINAL EXAMINATION

DR. DEWITT STETTEN presented a woman, age sixty-five years. On September 23, 1924, the patient had a ventral fixation with anterior colporrhaphy and colpoperineorrhaphy done for a complete prolapse of the uterus, with prolapse of the posterior and anterior walls of the vagina. On March 10, 1927, she was operated on at the Lenox Hill Hospital for internal hemorrhoids, which were removed by clamp and cautery. There was never any indication of any neurological disturbance and she seemed to void quite satisfactorily after the operation, never requiring catheterization. About a week after operation she began to complain of some abdominal distention and discomfort which was not relieved by colonic irrigation. There was no vomiting. March 19, Dr. Walter T. Stenson reported that he had examined the patient a short time before. The abdomen had been somewhat distended and while palpating the abdomen something seemed to give way under his hand, and the distention apparently disappeared. Doctor Stetten immediately examined the patient, who looked somewhat cyanotic and collapsed, although the pulse was 80, and of good quality. The temperature was normal. The abdomen was slightly distended and somewhat sensitive. X-ray examination showed several loops of distended ileum and apparently collapsed colon, and a diagnosis of intestinal obstruction of some sort, possibly due to a carcinoma of the

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colon, was made. Immediate operation was decided upon. A midline, supra-pubic incision was made and a large amount, about 2000 c.c. of free, straw-colored fluid, at first thought to be ascitic fluid, was found in the abdominal cavity. The fluid was removed by suction. Thorough inspection showed no evidence of intestinal obstruction, although there was some distention and injection of the lower ileal loops. The uterus was found to be adherent to the anterior abdominal wall from the former operation, and below this was found the urinary bladder, of tissue-paper thickness, with an irregular, intra-peritoneal tear at the fundus about two inches in length. It was then obvious that the intra-abdominal fluid was urine. The tear was closed by a triple suture line. An indwelling catheter was inserted into the bladder, the pelvis was drained, and the abdomen was closed in the usual fashion. About nine days after operation some urinary leakage was noted, which gradually ceased, but the patient had great difficulty in voiding spontaneously. Spontaneous voiding began about a month after operation, but frequent catheterization was necessary. Neurological examination by Dr. Russell G. McRobert showed some early combined degeneration of the posterior columns and the pyramidal motor tracts. By the time, however, of the patient's discharge from the hospital, May 10, 1927, voiding was practically normal, and since that time there has been no disturbance.

It is plain that this patient suffered from a chronic post-operative distention of the bladder, which was overlooked until she began complaining of her abdominal discomfort. According to the neurologist there is some neurological factor, but the fact remains that the wall of the bladder was extremely thin. Doctor Stenson, who is an extremely gentle and careful man, used no more than the average force in making the abdominal examination, showing that under certain conditions this is quite sufficient to produce a rupture of the bladder.

### THE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR AND CERTAIN DISEASES AND DEFORMITIES OF THE HIP-JOINT

DR. ROYAL WHITMAN read a paper with the above title, for which see page 442.

## BRIEF COMMUNICATIONS

### SARCOMA OF THE OVARY WITH UNUSUAL ORAL METASTASES

A GIRL of sixteen was referred to the service of Dr. V. P. Blair, of the Department of Surgery, Washington University Medical School, and Barnes Hospital, of St. Louis, Mo., because of loose, painful teeth and swollen gums. She was unable to bite and could take only very limited amounts of anything by mouth.

About six weeks previously, she had had pain in all her lower teeth which spread to the uppers, the teeth became loose and the gums sore. She had had many kinds of treatment, the condition having been diagnosed pyorrhœa; and seven teeth were extracted just before she was seen on this service. She had become very weak and mentally dejected by the time we saw her.

The upper and lower molars were missing and most of the remaining teeth were loose. The sockets in the four molar regions showed an exuberant mass of dirty red granulations 2 cm. across. In some areas the mucous membrane appeared to be growing over the granular mass. The breath was foul and the patient was weak, toxic and in mild acidosis. (Fig. 1.)

X-ray showed some bone destruction in the lower molar region and of the periodontal membrane throughout both jaws. (Fig. 2.) The patient was prob-

ably below normal mentally, large for her age, was almost blind, and had coloboma iridis and epicanthus of both eyes. (A brother had a coloboma in one eye.) The forehead was low; speech was of muffled lisping type.

There was nothing in the examination on which to make an accurate diagnosis. Some sort of cryptic, low-grade infection of an unrecognized organism was suspected. She had been in a state school for the blind and the adequacy of her diet was questioned, but found to have been sufficient. In fact, she had had an excess of orange juice, so that there was no likely possibility of scurvy.

*Biopsy.*—One loose tooth was extracted and cultures made. These showed almost pure diphtheroid growths and the smears showed a few staphylococci, Vincent's organisms and some amœbæ. The bacteriology gave no special leads. Microscopic examina-



FIG. 1.—Shows the large granulomatous mass found in all four molar regions.

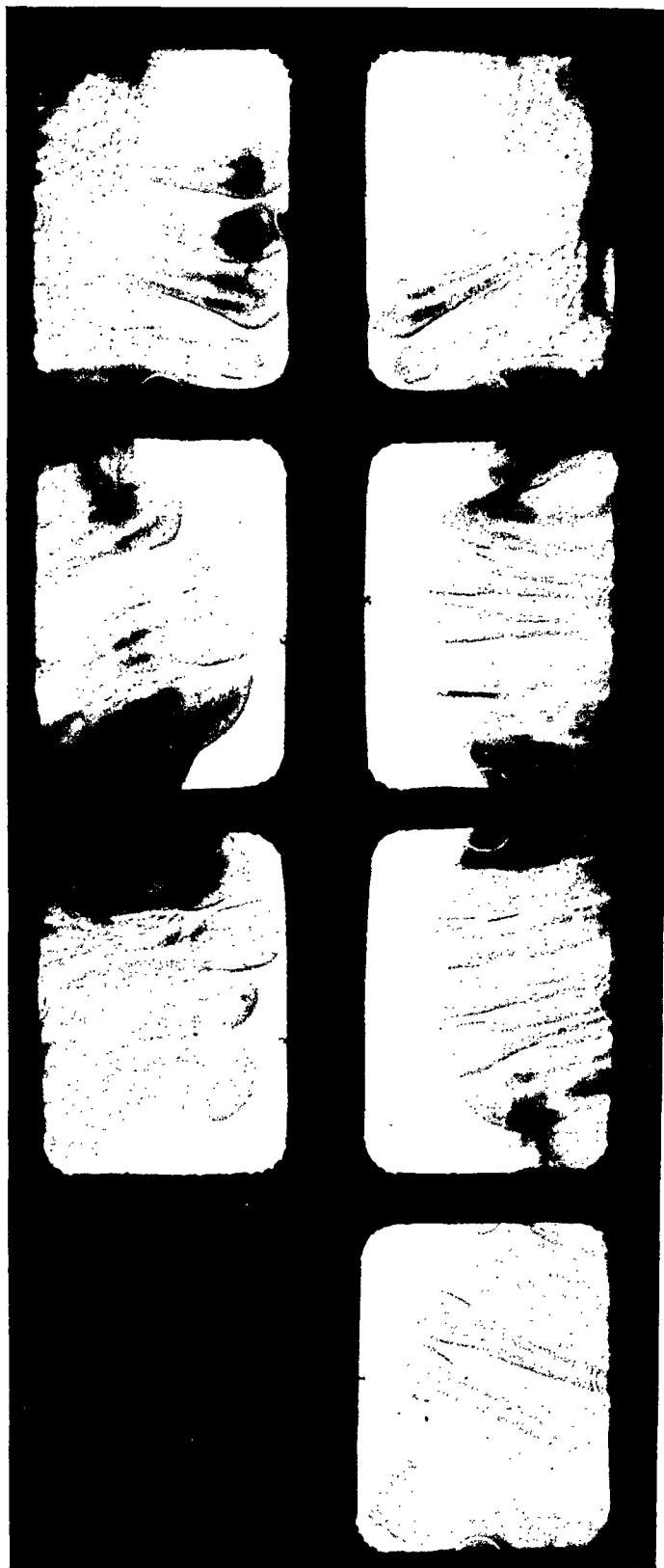


FIG. 2.—Shows absorption of the dental periosteum and of the bone in one of the molar regions.

tion of the gum tissue showed profuse round-cell infiltration with no special arrangement except for an apparent infrequent attempt at acinar formation. (Fig. 3A and B.) Because of the occurrence of the masses in four different areas at the same time, of the infection present and the X-ray evidence of bone involvement, definite views of the occurrence of a tumor were not formulated at first and treatment was guided along lines of local and general supportive measures.

The Wassermann was negative, urine negative, white blood count 6000 with 36 per cent. lymphocytes, red blood count 4,700,000, hæmoglobin 70.

Treatment at first was essentially to stop infection in the mouth and to keep up the patient's resistance, and many empiric things were tried. Transfusions, full diet (anti-scorbutic) with vitamins, milk injections, ultra-violet radiation, emetin intravenously, constituted the general treatment; and locally, good cleansing care was insisted upon with the use of potassium chlorate, methylene blue and salvarsan. In a week there was much improvement in the incidental infection, the discharge, odor and pain lessening and the teeth tightening up; but the enlargements persisted. In one molar region, the epithelium closed over the mass.

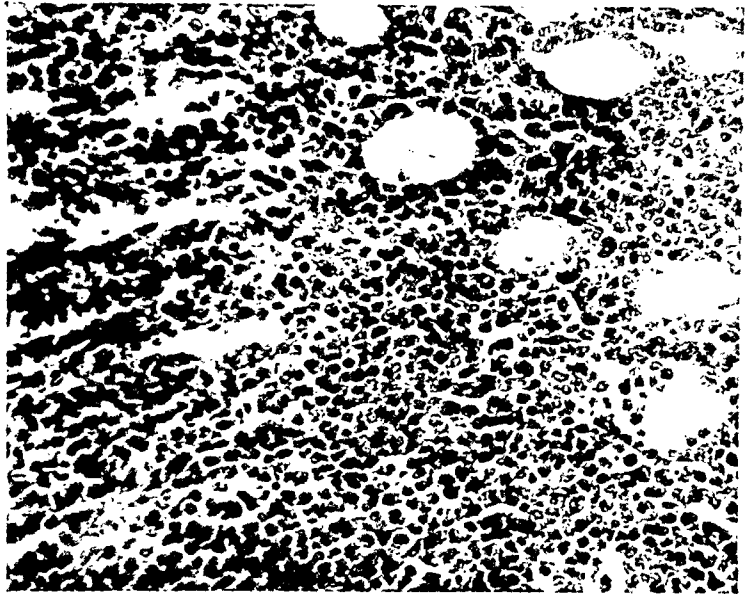


FIG. 3a.—From the gum tumors. Show profuse large round cell infiltration with one area showing something like acini. The cells are of different sizes and a few mitoses are seen.

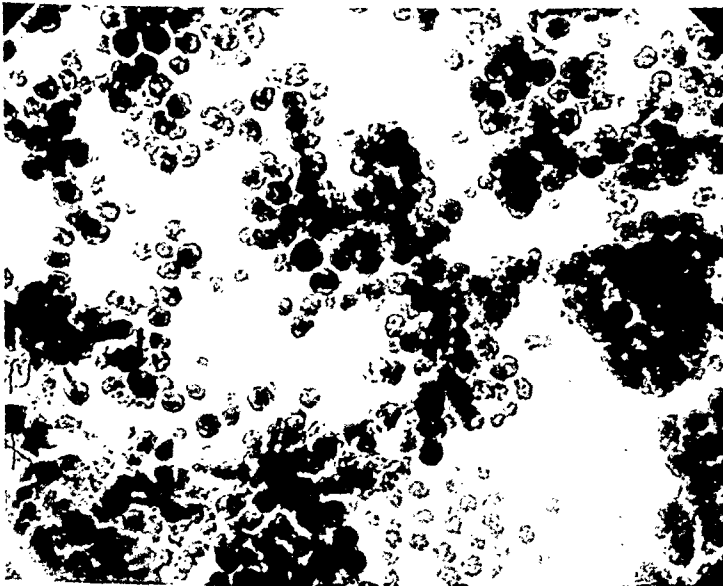


FIG. 3b.—See legend under figure 3a.

X-ray therapy was then used on the gums, and two days later the growths had almost disappeared, and on the sixth day there was practically no evidence of any tumor formation. There was a rather severe general reaction to the X-ray treatment with a good deal of distention coming on just after it which was thought due to the effect of the rapid absorption of the tumors.

The patient had been having pain in both flanks and at this time it settled in the right one and became very severe. An X-ray of

the pelvis showed a marked deformity with sacralization of the fifth lumbar vertebra on both sides, most marked on the right, with possible joint formation with the ilium. There was marked distortion of the whole pelvis and both ilia. (Fig. 4.)

At the time of the examination for the pain in the flank, a rectal examination was made and a tumor mass found anteriorly. Its nature and limits were not made out,

however, because of discomfort to the patient and because the pelvic deformity seemed adequate to cause the pain. The patient was put on a fracture board and in twenty-four hours the pain was gone.

At about this time, lumps were noticed in both breasts approximately 2 cm. in diameter. The abdominal distention persisted and warranted a more thorough pelvic examination.

Examination by Doctor O'Keefe showed the pelvis and lower abdominal cavity filled with a mass extending to two fingers below the umbilicus on the right and well into the cul-de-sac on the left. The mass could not be outlined or separated from the uterus. The mass was firm but not hard. There was free fluid in the abdominal cavity. The probability of malignancy was considered. Two days later this mass extended above the level of the umbilicus. This rapid growth could not be

FIG. 4.—Beside the bone deformity, there is shown a partial absence of intestinal gas in the pelvis. This is due to the tumor's filling the pelvis.

accounted for by physical examination. Because of this growth and distention without relief from enemata, it was decided to do an exploratory laparotomy at once.

On opening the abdomen, a large amount of free blood-tinged fluid was found in the abdominal cavity. Large ovarian tumors were found on both sides. The tumors were covered by the omentum which was heaped up near the top of the right tumor, which was ruptured at this point. Undoubtedly this rupture took place at the examination two days before and the omentum was attempting to cover up and wall off this raw surface, which accounted for the apparent rapid growth during this period. The tumors were pale in color and very friable.

The tumors were removed together with a piece of the omentum and the abdomen closed. A small nodule was removed from the left breast. Frozen sections from both ovarian tumors and the breast nodule showed lymphosarcoma. (Figs. 5A and B.)

Because of the rapid absorption of the gum tumor and the type of cell growth



FIG. 5a.—Sections from the pelvic and breast tumors. Show practically the same picture as the gum sections, with no apparent attempt at polarization.



## HORSESHOE KIDNEY

found, general deep X-ray therapy was recommended, but refused. The patient died on the thirteenth post-operative day.

At the Barnes and the St. Louis Children's Hospitals, in over 60,000 admissions, there have been only four cases of sarcoma of the ovary. The ages were six, seventeen, twenty-two and thirty-one. The percentage of occurrences of sarcoma of the ovary in Barnes Hospital and Children's Hospital was not estimated, although it is reported in the literature as occurring in from two to five per cent. of all ovarian growths.

Sarcoma of the ovary may occur at any age from fetal life on, but occurs much more frequently between the ages of twenty-one and thirty. It occurs much oftener than carcinoma in young girls.

The fact that the patient reported for treatment for the localized involvement of the gums adds especial interest. The primary focus was undoubtedly the ovaries. The simultaneous metastasis to several sites in the mouth at one time, without previous clinical signs from the primary focus, has not been seen by us, with one possible exception, nor can we find any reported cases. It may be possible that this already generalizing growth found lodgement in the gums on account of the trauma of the extraction or of the infection present.

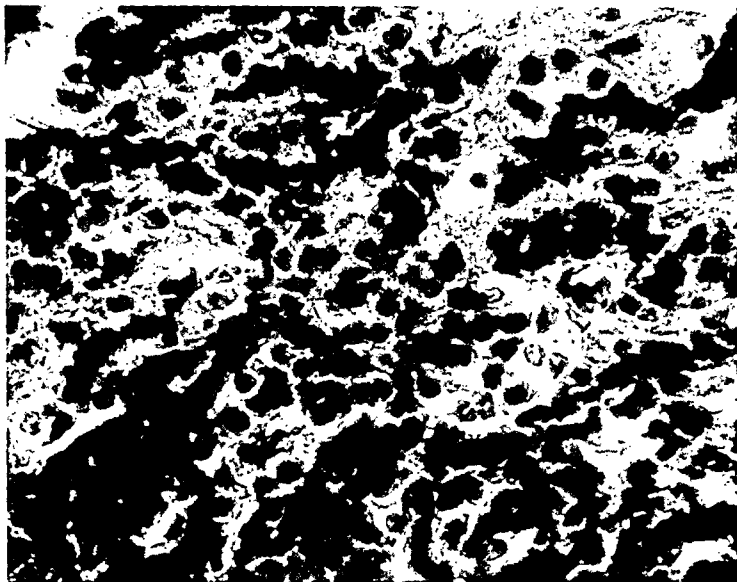


FIG. 5b.—See legend under figure 5a.

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JAMES BARRETT BROWN, M.D.,  
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## HORSESHOE KIDNEY

### INFECTED HYDRONEPHROSIS

THE following case has seemed worthy of reporting partly because it is a bit unusual but more especially because it serves to illustrate a few rather important points more particularly in connection with diagnosis.

It has been estimated by various observers that horseshoe kidney is noted at autopsies in the proportion of about 1-1000. The number of clinical cases

## BRIEF COMMUNICATIONS

reported would appear to show an even lower rate of incidence than these figures would indicate. This is rather surprising since the nature of the anomaly is such as to predispose strongly to pathological lesions of various sorts.

In 1924, I made a very careful search and found only 108 cases reported in the entire literature.\* To this group we were able to add three of our own

cases and we are now adding one more. This group included only clinical cases in which the diagnosis of renal pathology had been made and in which operative relief had been planned and carried out. It did not include autopsy records nor did it include cases in which the anomaly was noted accidentally in the course of operations upon other organs. It omitted also those cases in which the anomaly was noted in the course of making a complete urological examination but in which there was no co-existing pathology in the upper urinary tract. In this group of 108 cases a complete pre-operative diagnosis was made in only 24 or

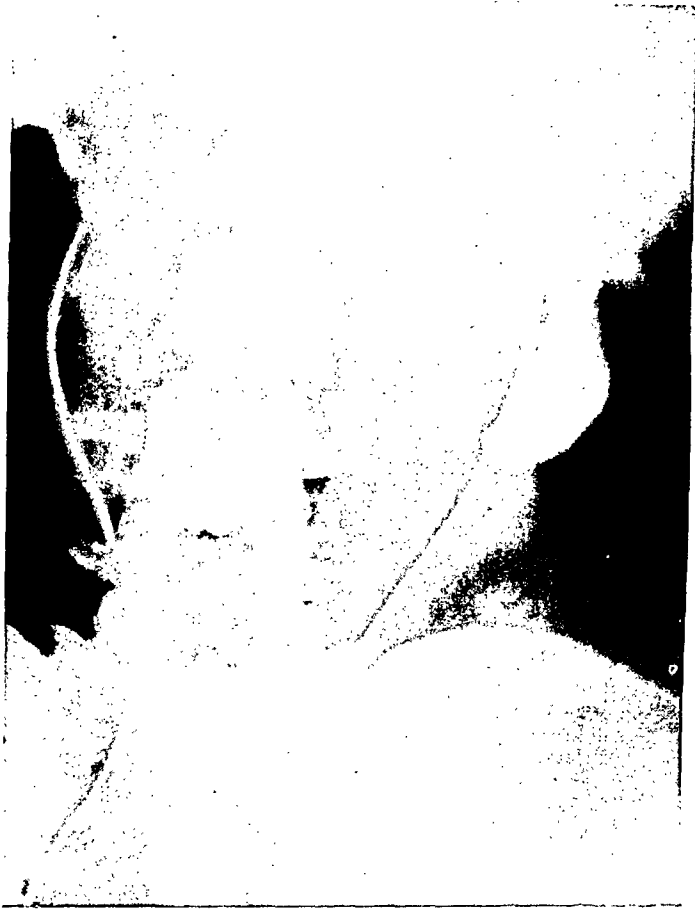


FIG. 1.—Left kidney pelvis much dilated, calyces indefinite, apparently not directed outward, part of pelvis medial to ureter, kidney outline not clearly shown.

22 per cent. That is: the pathology was recognized but the anomaly entirely missed in the majority of cases. It is only fair to say that a number of those cases were reported before the advent of many of our modern diagnostic methods. The later groups show a definite improvement in this respect but even the most recent fall short of what should be reasonably expected. This point will be referred to again in the discussion of the present case. Including the three cases reported in my paper of 1924 and the case about to be reported in this communication, we have had four cases in our service at The Brooklyn Hospital. In all cases the pathological lesion was correctly diagnosed but the anomaly was recognized in two only. In the remaining two it was missed pre-operatively and recognized first at operation.

\* J. of U., December, 1924.

## HORSESHOE KIDNEY

Following is a report of the present case: The patient was a single girl of twenty, first seen on October 5, 1927, who presented the following history: She was in perfectly good health until one year ago, since which time there has been slight frequency of urination accompanied by burning, on one or two occasions she has passed a little blood in the urine. One month ago she had a fever lasting for one week which her family doctor had diagnosed as grippe. One week ago, another attack of fever, this time associated with pain in the left loin, increased frequency and burning on urination. This time her doctor made a diagnosis of pyelitis and referred her to me for further examination. Examination discloses a young Italian girl apparently in good health. The general physical findings are entirely negative, except for some tenderness at the left costo-vertebral angle. Both kidneys are palpable, the left one apparently tender. The urine was cloudy and under the microscope showed very numerous pus cells.

Cystoscopy on October 6, 1927. There is a mild general diffuse cystitis; the ureter orifices appear normal and are normally situated, number 5 catheters pass readily to each kidney pelvis; clear urine flows in normal rhythm from the right kidney while from the left side there is a steady drip of cloudy urine. Phenolsulphonephthalein injected intramuscularly appears in normal time and concentration from the right side. On the left side there is not a trace of the dye in twenty minutes. Laboratory reports on the separated urines are as follows:

The bladder and left kidney urine showed numerous pus cells and *B. Coli* on culture. The urine from the right kidney was sterile and free from abnormal elements. A search for tubercle bacilli was negative. The urea was bladder 2.64, right kidney 1.88, left kidney 3.40. I am at a loss to understand the higher urea on the affected side unless it was that this represented the concentrated urine of retention. The blood count showed 12,400 leucocytes, with 77 per cent. polymorphonuclears. The Wassermann was negative and the blood chemistry showed urea 47.5; creatinin 2.13; sugar 129.4;  $\text{CO}_2$  combining power 51.9.

Following a plain X-ray of the entire urinary tract a pyelogram and ureterogram were made on the left, using 13 c.c. of a 15 per cent. solution of sodium iodide. The pyelogram shows a much dilated kidney pelvis of somewhat unusual shape with an atypical arrangement of the calyces. (Fig. 1.) The lower pole of the kidney could not be made out. This aroused our suspicions that we were dealing with a horseshoe kidney,



FIG. 2.—Pyelogram of right half of kidney; very irregular shape of pelvis and arrangement of calyces, some of them directed toward the midline.

## BRIEF COMMUNICATIONS

although there was standing against the diagnosis the fact that both kidneys could be palpated and were somewhat movable. For the purpose of clarifying the situation, a pyelogram of the right kidney was made three days later and this confirmed our original suspicions. (Fig. 2.) It will be noted that the kidney pelvis is very irregular in shape, that it is somewhat low and closer to the vertebral column than normal and that some of the calyces point toward the midline.

Diagnosis: Infected hydronephrosis in the left half of a horseshoe kidney.

Operation, October 14, 1927. An oblique incision was made extending from the top of the twelfth rib to the outer border of the rectus, about one inch above the symphysis.

An irregular shaped kidney was exposed with a much dilated pelvis presenting on the anterior aspect. Crossing it obliquely was a rather small thickened ureter opening into the pelvis near the hilum with the greater part of the pelvis well below it. The upper pole of the kidney was readily mobilized, the lower pole firmly fixed. Upon tracing this down there appeared in the wound well to the left of the midline the lower pole of the right half of the kidney and connected with the left half by a band partly fibrous about two inches wide and one-half inch thick. A mattress suture was placed in the lower pole of the right kidney near the band, which was then crushed with a heavy clamp and ligated with suture ligatures of chromic gut and the two halves of the kidney separated. This was readily accomplished and there was no bleeding. The remainder of the operation was like an ordinary nephrectomy. It is interesting to note that the vessels entered the hilum at the usual site and that there were no anomalous vessels. The wound was closed in layers with a cigarette drain at the dependent angle.

The patient made an uneventful recovery

and left the hospital on the fifteenth day post-operative with the wound entirely healed.

Horseshoe kidneys occur with a fair degree of frequency. The very nature of the anomaly predisposes them to various forms of pathology, chiefly because of the irregular arrangement of the pelvis and ureter, which is not conducive to good drainage and hence harbors infection. It is obviously important that the anomaly as well as the pathology should be recognized and yet a complete and accurate diagnosis is unusual in the majority of cases. It is my opinion that, if the diagnostic problem is properly approached, a correct diagnosis should be made in practically 100 per cent. of the cases. The first point is to bear in mind that such a condition may exist, although there are few if any subjective symptoms to suggest it. The most important desideratum is the desirability of subjecting every patient in whom there is

## HORSESHOE KIDNEY

a suspicion of any pathology in the kidney or ureter to a comprehensive examination of the entire urinary tract, including pyelogram and ureterogram of the side under suspicion and where indicated for the purpose of comparison, a pyelogram of the opposite side made at another examination a few days later. I have advocated this policy for several years and have practiced it in my clinic and have never had an occasion to regret it. While it is true that many patients are subjected to much more of an examination than is required to make a diagnosis in their particular case, yet it does them no harm and, on the other hand, I feel that, by following this policy as a routine we often pick up little points that might readily be overlooked with a more casual examination, to say nothing of the fact that we are often able to make a complete diagnosis at one sitting and in that way spare the patient the discomfort and expense of repeated examinations. There is a little wave of feeling among urologists at the present time that pyelograms are being employed too often and too indiscriminately and that they should only be used as a diagnostic proceeding when there are very special indications. I disagree entirely with this attitude. For several years now we have made about one thousand pyelograms annually in our clinic and since using the 15 per cent. solution of sodium iodide, not a single one of this fairly large group has given me one moment's anxiety because of any deleterious effect from the method. It seems to me that a diagnostic procedure which is so innocuous and so often productive of information may well be adopted as a routine. In the case just reported the diagnosis would have been entirely missed without the pyelogram of the affected side and a pyelogram of the opposite side was essential for confirmation.

The diagnostic points of value in the radiographic diagnosis are as follows: The lower pole of the kidney is not definitely outlined. This is important, particularly if the upper pole is clearly seen. Occasionally, as happened in one of my cases, the entire mass, including the isthmus, may be demonstrable. The pelvis is apt to be lower and nearer than normal to the midline, often mesial to the outline of the ureter. A line drawn through the long axis of the pelvic forms an acute angle with the vertebral column opening upward. The opposite prevails in the normally situated kidney. The pelvis is irregularly shaped and the calyces are atypical in their arrangement, some of them often extending toward the midline. When this combination is noticed on the side under suspicion, the diagnosis is strongly suggested. If a similar condition prevails on the opposite side, it is practically confirmed. All of these points are readily noted if one is looking for them; they are easily missed if one is not alive to the possibilities. I am confident that more and more of these cases will appear in the literature in the future and I am equally confident that the ratio of diagnostic accuracy will be much better than the 22 per cent. noted in the review of 1924 or the 50 per cent. noted on our own four cases.

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## ENTEROSTOMY IN TYPHOID PERFORATION

The value of prophylactic, or complementary enterostomy in abdominal surgery has been conclusively shown. It has been employed in resections of the large bowel, and it is routinely done in this clinic. In cases of intestinal obstruction, with or without mechanical cause, many surgeons have employed it to avoid the dangers of paralytic ileus. More recently in suppurative appendicitis where ileus is present or feared, enterostomy has reduced the mortality perceptibly.

I have had within the past two months two cases of typhoid perforation of twelve hours' duration; the first was treated by closure of the perforation, enterostomy and drainage. When the second one came in, it occurred to me to try a procedure I do not remember seeing described before. Instead of closing the perforation with a purse-string suture, and doing an enterostomy proximal to it, I inserted a small rubber catheter into the ileum through the perforation and sutured it in place after the Witzel method. The catheter was brought through a stab wound in the flank; the incision was closed. Both patients drained freely through the catheter, and there was no distention. Their convalescence was uninterrupted, the catheters came out in ten to fifteen days and the fistula closed spontaneously and promptly. Both were discharged well.

If there should be more than one perforation, I should close the distal ones as usual and insert the catheter into the proximal one. The fact that in these as well as in similar cases death is so often due to the results of paralytic ileus, enterostomy will certainly prove a life-saving measure. The procedure described is so simple, works so well and proved so satisfactory it seemed worth reporting.

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## BOOK REVIEWS

POLIOMYELITIS, WITH ESPECIAL REFERENCE TO TREATMENT. BY W. RUSSELL MACAUSLAND, M.D. Octavo, cloth, pp. 402, profusely illustrated. Lea and Febiger, Philadelphia, Pa., 1927.

This book ably and comprehensively presents the important subject of poliomyelitis, bringing the advances in experimental study and treatment up to date. As would be expected, when an orthopædic surgeon writes upon this subject, special attention is given to treatment, but history, etiology, pathology, diagnosis, prognosis and symptoms, in Part I (about one-third of the book), are fully presented. This part reflects intensive study of what others have done. In reviewing and ably marshalling the observations of other workers, the author has given due credit and each chapter is followed by its own bibliography. In Part I, the writer weighs the evidence on the vexed questions of bacterial etiology, of immunization and of vaccine therapy. This part also includes an interesting review of the history and of the spread of the disease in epidemics in both hemispheres; it clearly presents the pathology, symptomatology and diagnosis, and rightly advances a better prognosis as to ultimate usefulness than is often expected or taught. Part I should be of especial interest to the general practitioner, to the pediatricist and to the neurologist.

Part II (two-thirds of the book) is devoted to treatment. In its first chapter, there is a good outline of the symptomatic treatment of the febrile stage, of the symptomatic and muscle conservation treatment by local protection of the early paralytic stage and of the protective and muscle development care of what might be called the mid-paralytic stage; and finally of the great advance in reconstruction by operation, when the residual paralyses are established. For the febrile and early paralytic stages, the use and place of lumbar puncture, of vaccines and of drugs is discussed. Here also is found a clear presentation of the mechanical causes of deformity and of its prevention. Could the general practitioner thoroughly know the principles presented in this chapter and authoritatively transfer that knowledge to patients and to parents, it is believed that much of the disability and deformity which follow poliomyelitis would be lessened.

The remaining chapters are devoted to specific orthopædic problems in treatment. The disabilities and deformities of the lower extremity, of the upper extremity and of the spine and trunk are presented seriatim and fully. Protection by braces, by plaster-of-Paris dressings is detailed for specific conditions; graduated and progressive muscle training principles and lists are applied each to its disability. Finally the methods of reconstruction, by operation, when preliminary care has left a disability or disabilities upon which no further advance may be expected, or when neglect has left these disabilities plus deformity, are described for many individual conditions.

## BOOK REVIEWS

This part reflects the author's personal experience. The procedures are fully illustrated—even, as in Whitman's astragalectomy, more fully than did the originator of the operation. The indications for tendon transplantation and for "bone carpentry" work are differentiated. One misses reference to the valuable principle of partial or stop-joint fixation of joints by the use of transplanted autogenous "living ligaments", made from twisted fascia lata, as described and used by Gallie. This procedure has found a definite place in operative paralytic reconstruction; its omission in this work is regrettable.

Viewed as a whole, this book shows thoughtful library research and careful adaptation of the matter there found and much personal experience in the practical side, which is instructively presented. There is a full index at the end of the book.

WALTER TRUSLOW.

PRACTICE OF UROLOGY AND SYPHILOLOGY. A Surgical Treatise on Genito-urinary Diseases and Syphilis. By CHARLES H. CHETWOOD, M.D. Profusely illustrated. Octavo, cloth, pp. 879, 4th edition. New York, William Wood and Company, 1927.

The first edition of Doctor Chetwood's book appeared in 1913. It at once acquired an authoritative position in the specialty to which it was devoted, which has been maintained in the successive editions which have been since called for. It must be a cause of much satisfaction to the author, as the years of his own life have been added to until they now have brought him among the seniors of his profession, to see the permanence of the work he has done and the importance of the structure that he has builded. At the beginning of this period, Urology had already been accepted as an important surgical specialty, an importance which has steadily increased to the present time due to the advance in the knowledge of pathology, the improvements in diagnostic methods and the greater possibilities of adequate treatment which time has brought. To the urological part of his scheme, Doctor Chetwood has devoted 725 pages of his book. His statements of fact are brief and condensed but clear. So extensive has become the field, however, that one cannot help but feel that even so many pages of a book are not adequate to do full justice to the subjects treated. As one reads, one's appetite is whetted for more than the author could have given. This is merely a bald statement of the present field of surgical science and practice in any one major department of which now demands for its adequate treatment more space than did the whole field of surgery in the days of Erichsen, Syme or Gibson. This is especially true of the part of the book devoted to syphilology, occupying 124 pages. One finds it difficult to justify the association of syphilis with urology; it is certainly not a necessary one; true in many instances, it finds its origin in a lesion of a urological organ; a fact which, however, is an accident, rather than a constant. As a disease, it has a far more important relation to almost any other tissue or set of organs than to those of the uropoietic system.

LEWIS S. PILCHER.



## BOOK REVIEWS

THE OPERATIONS OF SURGERY. By R. P. ROWLANDS, M.S., F.R.C.S., and PHILIP TURNER, M.S., F.R.C.S. Seventh edition, large 8vo, cloth, 2 vols., pp. 1046 and 896; profusely illustrated. The Macmillan Company, New York and London, 1927.

Twenty years ago, in 1907, it was the privilege of the writer to review in the ANNALS OF SURGERY, vol. xlviii, p. 951, the fifth edition of *Jacobson's Operations of Surgery*. Mr. Jacobson, in that edition, acknowledged the joint authorship of Mr. Rowlands. The book, in its seventh edition, again appears on our table for review, but has lost the name of Jacobson. Rowlands is now the senior author, while as a junior colleague, his fellow surgeon at Guy's Hospital, Mr. Turner, has been added. As is most proper, the present authors pay a deserved compliment to their predecessor in the compilation of the book. In their words, the book was first written by "that incomparable and gifted teacher, the late Mr. W. H. A. Jacobson, who, endowed as he was with great natural and literary ability, extensive surgical knowledge, ripe judgment and endless energy, was able to make the book an immediate and lasting success. Jacobson devoted over twenty years to succeeding editions, allowing himself hardly any spare time and often working in the small hours when he ought to have been asleep. Let us hope that the book may remain a lasting memorial to his genius and industry."

Mr. Jacobson died in 1924. Should his personality be still conscious of earthly conditions, it could not fail to delight him that the work to which he gave himself with such devotion during his life in this world was still being carried on by able and enthusiastic successors whom he had himself trained and imbued with his own enthusiasm.

This is a Guy's Hospital book. It is dedicated to that hospital, and its authors are members of its surgical staff and lecturers in Surgery in its Medical School. It is not desirable here to make a detailed review of its scope or of its chapters. It is a practical book, an up-to-date book. It has evidently been especially prepared with a view to the needs of younger and inexperienced surgeons. In this latest edition it is apparent that much of it has been rewritten to make it properly embody the surgery of to-day. All surgeons will find it an excellent and authoritative guide.

JAMES T. PILCHER.

RADIUM IN GYNÆCOLOGY. By JOHN G. CLARK, M.D., CHARLES C. NORRIS, M.D., and GIOACCHINO FAILLA, E.E. Large octavo, cloth, pp. 303. J. B. Lippincott Company, Philadelphia and London.

Medical literature, during the past few years, is so replete with reference to the use of radium in various conditions, that it is with interest and profit that one reads the present and probably pioneer exposition of its employment in gynæcology by authors especially qualified to correlate the scientific and practical aspects of the questions involved. The first half of the work is taken up by an exhaustive and scholarly consideration of the physics of radium. This section, while of unquestionable intrinsic interest, will certainly best be

## BOOK REVIEWS

appreciated and understood by special workers, especially by those in the field of preparation of the substance for practical use. This section is preceded by an introductory chapter reciting the history of the discovery of radium and the relation of Becquerel, Rutherford, Schmidt and Curie to the development of its recognition. The life of Mme. Curie is of dramatic interest.

The authors are most emphatic in their attempt to make one realize that its indiscriminate use should be guarded against and that insufficient knowledge and experience are likely to do much harm. Their primary concept is accuracy of diagnosis and they base their efforts at treatment on a sound knowledge of pelvic pathology and objective findings, acknowledging the paucity of actual demonstration as to just how radium affects carcinoma, but recite the conditions and pathology which they have noted to be most beneficially affected in the observation of a convincing number of cases.

This is included in the chapters dealing respectively with tumors of the external genitalia, vagina, cervix uteri, body of the uterus, myoma uteri and myopathic hemorrhage, cervicitis, sterility and dysmenorrhœa. The type of cases suitable for treatment in these regions, their recognition and the technic of radium application are definitely stated.

The volume is certainly a real addition to our armamentarium in the treatment of pelvic conditions and should be carefully read by those attempting to employ this agent in the field of gynecology.

JAMES T. PILCHER.

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# ANNALS *of* SURGERY

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## SUTURE OF THE RECURRENT LARYNGEAL NERVE FOR BILATERAL ABDUCTOR PARALYSIS\*

BY FRANK H. LAHEY, M.D.

OF BOSTON, MASS.

ONE reason for reporting the following case of successful direct anastomosis of the recurrent laryngeal nerve in a case of bilateral abductor paralysis is to put the case on record. The main reason, however, is for the purpose of demonstrating that there are cases, perhaps only occasional ones, in which the nerve trunk itself may be found, freed from its scar and sutured successfully, and to encourage others to investigate the possibility of such a procedure early in the course of this very distressing condition for which operative procedures have so frequently been unsatisfactory.

The patient was a woman, aged forty years, unmarried, and a stenographer by occupation. She had been operated upon for exophthalmic goitre by a surgeon in a neighboring city eight months previously, a subtotal thyroidectomy being done. Her voice disappeared completely for two months after operation and, although now able to talk in a high-pitched voice, she still has spells of hoarseness, and since the operation has been having increasing difficulty with breathing, until now any unusual exertion threatens her with suffocation. Five months after the operation the thyroid remnant on the left side of her neck began to enlarge, and she became very nervous and weak.

The patient entered the clinic June 11, 1926, because of persisting thyroidism and difficulty in breathing. She was examined by Dr. T. W. Herman, associate laryngologist to the Deaconess Hospital, who reported: "This patient has a bilateral abductor paralysis. The glottic space is so small that one would expect dyspnoea on the slightest exertion. Good adduction and, therefore, her voice sounds are almost normal. General anaesthesia absolutely contra-indicated."

On June 25, 1926, with local anaesthesia, the skin flap of the previous operation was elevated, the prethyroid muscles on the right side were cut, and the small stump of thyroid tissue remaining after the previous lobectomy was freed and turned inward. Behind this the right recurrent laryngeal nerve was found and followed up to the horn of the thyroid cartilage. Just below this point a neuroma was found in the nerve where it was caught in a pale thick scar fixing it to the lateral laryngeal wall. Some of the fibres of the inferior constrictor muscle were cut away, so that the upper portion of the nerve could be demonstrated. The nerve was freed from the scar, the segment of the nerve containing the neuroma was removed and an end-to-end suture of the nerve made without difficulty and without tension, using two interrupted oiled silk vessel sutures.

On July 1, the patient was discharged with the wound clean.

On August 3, of the same year, the patient was seen again and states that her voice is lower pitched and that she has been breathing much better since the operation.

On October 19, 1926, the patient was again seen and reports that she is now able to breathe well, goes up and down stairs without difficulty in breathing and that her

\* Read before the American Surgical Association, May 14, 1927.

voice is much better. She was examined by Doctor Herman on this date, who reported definite movement in her right cord.

This patient was last seen on March 17, 1927; able to breathe well and has been at work for several months. She was seen by the laryngologist, Doctor Herman, on this date, who reports as follows: "The right cord shows definite movement. It has by no means the normal excursion, perhaps one-third abduction, while adduction is good. The left cord is fixed. Her speaking voice has good tone quality. The glottic space is ample for all ordinary activity."

"She has recently had an acute infection of the upper respiratory tract without any local discomfort. It is possible that still greater motility may develop in the movement of the right cord."

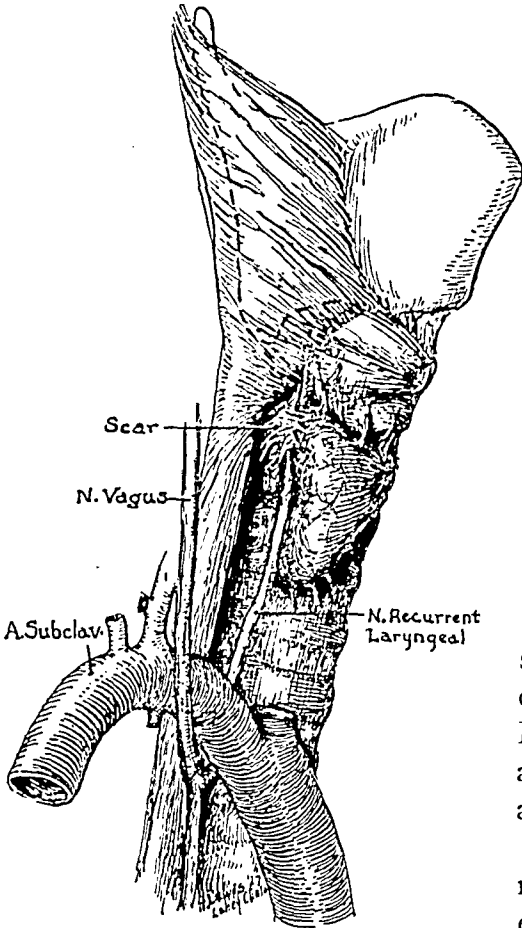


FIG. 1.—Shows the scar binding the nerve to the larynx. The remnant of thyroid gland has been turned forward.

In view of the pre-operatively demonstrated bilateral abductor paralysis, the narrow glottic space, the symptoms of respiratory difficulty and the operative demonstration of the scar in the nerve, the complete severance and suture of the nerve with return of abduction, widening of the glottic space and relief of breathing difficulty, it would appear that there can be little question but that this is a successful suture of the recurrent laryngeal nerve with return of function.

Although no report of a successful suture of the recurrent laryngeal nerve could be found in the Boston Medical Library, nevertheless it is quite probable that successful suture has been accomplished before.

We have been extremely fortunate regarding this lesion. In an operative experience with 4700 thyroid operations upon approximately 4000 patients, we have never seen bilateral abductor paralysis as an immediate or remote complication of the operation.

The innervation of the muscles of phonation and the effect of injury to the superior and inferior laryngeal nerves upon those muscles is by no means a settled situation. We may summarize our knowledge of this subject briefly as follows:

Russell<sup>1</sup> demonstrated in 1892 that the recurrent laryngeal nerve has two sets of fibres; that they may be separated into two bundles and stimulated separately, one producing abduction and the other adduction. Grabower is said to have shown that there are twice as many fibres in the adductor bundle (680) as in the abductor bundle (281). Semon and Horsley<sup>2</sup> demonstrated

## SUTURE OF THE RECURRENT LARYNGEAL NERVE

that prolonged stimulation of both bundles results in paralysis in the abductor bundle sooner than in the adductor bundle.

Hooper<sup>3</sup> and Donaldson<sup>4</sup> demonstrated that electrical stimulation of the entire nerve, of increasing strength, produced varying effects upon the cords, first abduction and then adduction.

It has been assumed and generally accepted that if the recurrent nerve is completely paralyzed, as by cutting, the cords will assume the cadaveric position which leaves ample breathing space between them. New,<sup>5</sup> however, states that following subtotal thyroidectomy and injury to the recurrent laryngeal nerve, the cords do not assume the cadaveric position, but the position of adduction. He also states that those cords which may at first assume the cadaveric position later reach the median position. This would account for the difficulties in breathing which come on occasionally a few months after the subtotal thyroidectomy.

On almost every side of this question one may find conflicting opinions and contradictory experiments, so that it must be admitted that our conception of the mechanism of the vocal cord abnormalities which occasionally follow operations upon the thyroid gland are not satisfactory.

It is quite probable that time and further investigation will demonstrate that the superior laryngeal nerve is less of a sensory nerve and more of a motor one than is now so frequently assumed. If this is so it will clear up some of our present probable misconceptions. Dilworth<sup>6</sup> has published a fairly recent paper (1923) dealing with the anatomy of the nerves of the larynx based upon naked eye dissections of 33 human larynxes. His conclusions so admirably summarize the situation as to the laryngeal nerves that they are set down here.

He states that there are four ways of looking at the laryngeal nerves:

1. The classical way, following Luschka, that they are separate sensory and motor nerves.
2. The school of Exner, which says that they are mixed motor and sensory nerves, and that each muscle received a double nerve supply.
3. An obvious middle way, which says that the nerves are mixed nerves, but which denies that all the muscles of phonation have a double nerve supply. (Dilworth found that the interarytenoideus was supplied by both the internal (a branch of the superior laryngeal); and the recurrent laryngeal nerves, but that the rest including the cricoarytenoideus posticus had only a supply from the recurrent laryngeal nerve).
4. He does not believe that this fits in with all the facts, such as the

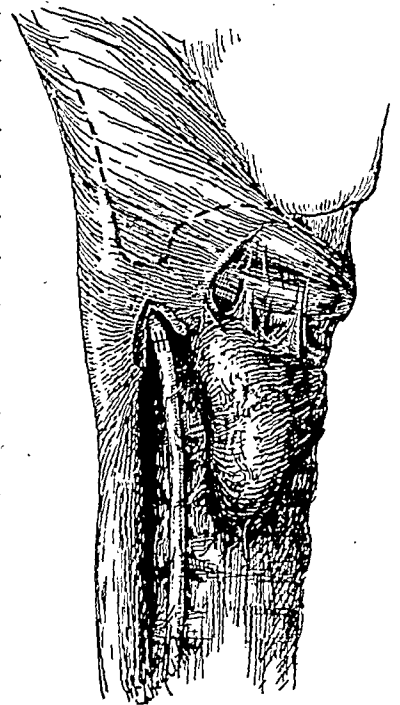


FIG. 2.—Shows the direct suture of the nerve and cut fibres of the inferior constrictor. The remnant of the thyroid gland has been turned forward.

demonstrated connections (*ramus communicans*) between the superior and inferior laryngeal nerves and their branches and suggests that just as the vagus breaks up into various plexuses in the body, it does the same in the larynx and becomes a highly modified plexus here.

It seems that there will always be great difficulty in the study of post-operative abnormalities of the muscles of phonation following thyroid operations, because while one may see that some injury to the innervation of these structures has taken place and the variation in position of the cords may be observed, nevertheless it is not possible to know where the injury to the nerve is or what the injury is, so that a constant type and location of nerve injury may be related to constant positions of the cords following this injury.

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# TREATMENT OF SUPPURATION OF THE LUNG\*

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As a basis for this study I have selected the cases with intrapulmonary suppuration who were admitted to the wards of the Lenox Hill Hospital during the last five years, and have added such other cases for illustrative purposes which have received my personal attention over a somewhat longer period. There were 105 patients in all. A few developed an acute condition at the hospital, others were admitted in the acute stage of the disease, but the majority were subacute or chronic at the time of admission. Some of the patients came to the hospital because of an acute exacerbation, others who had become accustomed to their affliction, because they based their hope for relief on some new method of treatment, and a few were so discouraged or desperate that they were willing to have anything done.

For purposes of study and treatment it is practical to classify patients into groups. In the literature one finds several classifications, some help one in understanding the disease, others lead to more confusion than already exists. It is sometimes not possible to assign an individual case to any well-defined group. Though cases may differ as to etiology and early pathology, they may become more nearly alike as the process continues. For this reason the terms acute and chronic lung suppuration have been much used of late. In addition to the consideration of the time element, however, I believe that the division of cases into the following three main groups is of value:

I. *Suppurations limited to or originating in the bronchial tree, known as bronchiectasis.* From the nature of the condition it is apparent that aspiration of foreign substances, infected or otherwise, is the probable etiological factor. The process may start insidiously or more acutely. At times the inflammation is confined to one lobe and remains there, at other times a gradual extension to other lobes can be made out until the process is bilateral in character. The lower lobes are affected more often than the upper. While in the beginning the inflammation is no doubt limited to the mucous membrane, leading to thickening and profuse exudation, it later spreads to the surrounding tissue and produces a pneumonitis and finally fibrosis. In those cases of aspiration in which putrefactive and pus-producing organisms play a rôle, a destructive process may start early, leading to a rapidly spreading gangrenous abscess. In the less severe cases the walls of affected bronchi may become weakened, leading to a slow perforation with gradually developing secondary abscess, a so-called bronchiectatic abscess.

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II. *Suppurations of the lung parenchyma outside the bronchial tree, commonly known as lung abscess.* They are much less common than those of the first group. They usually start in a pneumonic focus with breaking down of tissue and liquefaction. Much depends on the organisms involved. It is probable that pure pneumococcus infections infrequently lead to abscess formation. The latter is more common in broncho-pneumonias of streptococcus or staphylococcus origin and where pus-producing organisms act as secondary invaders. Another common cause of these abscesses are septic emboli carried to the lungs through the pulmonary circulation. Another possible cause is an aseptic infarct which secondarily becomes infected. In case the infection is of low virulence, the abscess may later become well encapsulated and pass into the chronic stage. Coincident with this development the walls become hard and sclerosed and eventually the entire process may resemble a bronchiectatic abscess. In the more virulent infections, on the other hand, the abscess steadily increases in size, there is destruction of tissue, possibly

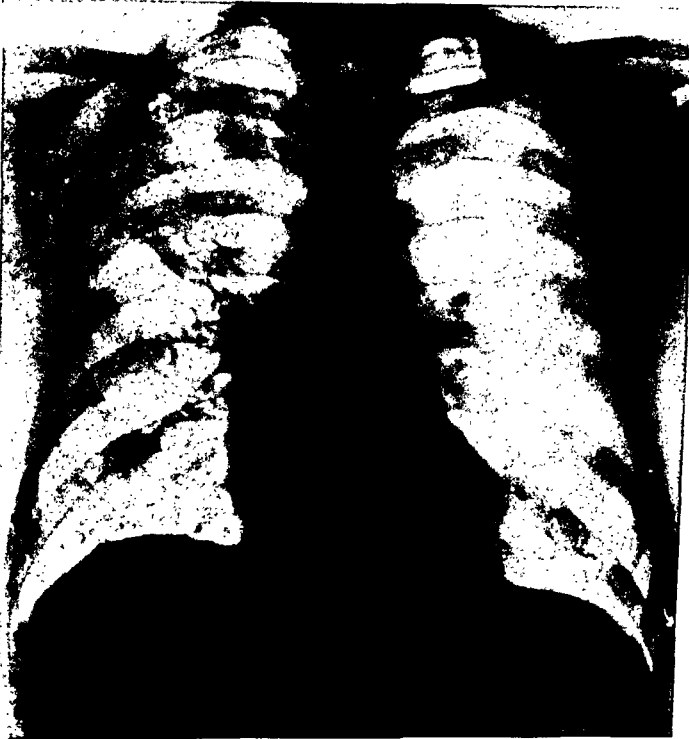


FIG. 1.—Acute lung abscess, right upper lobe with cavity found also on fluid level.

with gangrene. Eventually it may perforate into a large bronchus or pleura.

III. *Massive gangrene of the lungs.* This classification is reserved for those cases in which a large portion of a lobe or an entire lobe becomes gangrenous and is extruded. It is probably always due to blocking of a blood-vessel by a septic embolus or thrombus with massive destruction of the involved tissue. A secondary exudate will develop around this necrotic mass of lung and the clinical picture presented is that of an empyema, perhaps with signs and symptoms suggestive of an intrapulmonary lesion. The condition is not common, at any rate it is not often diagnosed. Of our cases only three belonged to this group.

What becomes of all these acute intrapulmonary suppurations if left untreated or if treated only by medical means, by many authors called expectant treatment? One of several courses may be followed.

I. Some of the very septic cases, with high fever and prostration, run a



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rapid course and end fatally. They are nearly always associated with spreading gangrenous inflammation.

2. That a certain number of the milder forms heal spontaneously is well known. In some of these the true pathology may not even have been recognized. They may have been diagnosed as pneumonia with delayed resolution, chronic pneumonia or putrid bronchitis. Modern investigations have repeatedly uncovered such cases to be really lung suppurations. Then there are some empyema cases originating from a peripheral lung abscess which could not be recognized and were not even suspected and which heal while the empyema is draining. But there are also real lung abscesses or early bronchiectasis cases, recognized as such, which go on to complete cure. On account of the diagnostic difficulties, it is manifestly not easy to give definite percentages of such cures, nevertheless several authors have given us statistics. Whittemore<sup>1</sup> reports about 13 per cent. recoveries, Miller and Lambert<sup>2</sup> 50 per cent., Lockwood<sup>3</sup> 59 per cent., Wessler<sup>4</sup> 33 per cent., Lord<sup>5</sup> 11 per cent. To interpret such wide differences is not easy, the explanation has to be sought in differences in virulence, especially in different parts of the country and under different climatic conditions. Some authors have reference to special types of cases only, and some may include in their statistics cases which are rejected by others. It should be our aim to include only such cases as by a combination of history, symptoms, physical signs and Röntgen-ray become clinically recognizable. Even then it is difficult to reach a definite understanding, because in the beginning the process may be what is called putrid bronchitis, or broncho-pneumonia, or an infarct, especially in the post-operative cases. Many of these clear up and it is only when there is some disturbance with the expulsive mechanism, leading to retention of septic material, or when there is secondary invasion with putrefactive organisms, that the condition passes over into the stage of lung suppuration. The method of healing in these cases is by absorption or by evacuation *via* the bronchial tree. Among our acute cases there were only eight discharged as cured; the percentage is small as compared with several other authors, perhaps due to the fact that we included only such cases as complied with the diagnostic requirements mentioned above. The two following cases are illustrative of the group:

CASE I.—G. M., forty-one years old, was admitted May 28, 1927, complaining of cough and foul expectoration. He was taken ill five weeks previously with what was diagnosed as pneumonia. He had been in bed only one week. He had continued to have pain in the right side of the chest with cough, but without sputum. He perspired freely and ran an intermittent temperature. He had lost 20 pounds in weight.

Examination showed dulness over the right upper lobe with harsh breathing. There were no definite signs of consolidation or of a cavity. He expectorated foul-smelling pus at times and his breath had a "lung abscess" odor. Change in position did not increase the amount of sputum. Latter contained staphylococcus albus, micrococcus catarrhalis and pneumococcus. The X-ray examination showed density with a cavity and fluid level (Fig. 1). Largely on account of the non-communication with a bronchus, operation was indicated to prevent spreading of the suppurative lesion in the lung. The patient ran a septic temperature, and operation was advised, but he absolutely refused

and left the hospital, June 6, 1927, with a temperature of  $103^{\circ}$ , and went to the country. When seen a few months later he had regained his weight, had no symptoms, and the X-ray showed complete disappearance of the infiltration (Fig. 2).

CASE II.—R. S., sixty-one years old, was admitted October 29, 1924, with a suppurative lesion of the right chest of comparatively short duration. He complained of cough and expectoration of pus and blood, with considerable loss of weight. His temperature was normal. Sputum was negative for tuberculosis. Physical and X-ray examination showed a lesion of the right lower lobe which was diagnosed as bronchiectasis (Fig. 3).

As the patient showed tendency to improve slightly, he was discharged with instructions to remain under observation, which he followed. He made a complete recovery clinically and also as far as X-ray examination of his chest is concerned (Fig. 4).



FIG. 2.—Acute lung abscess. Spontaneous cure, six months later.

3. Some abscesses perforate into the pleura. This is not an infrequent occurrence with those situated near the periphery. If the perforation is small, a slow leak results with a well-encapsulated pocket of pus. In case it is larger a regular empyema forms, which sinks to the lower part of the pleural cavity. Sometimes a sudden perforation takes place, especially during a coughing effort, resulting in an acute pyopneumothorax. A perforation into the pleura and bronchus may take place at the same

time. About two years ago I<sup>6</sup> reported a group of ten cases of this type, all of which had recovered, indicating that perforation of a lung abscess into the pleura, especially if it takes place slowly, is prognostically a good sign. If the opening of the abscess into the pleura is large, sufficient drainage takes place and a cure will result by draining the empyema. If the opening is small, one may have to operate on the abscess later, as in three of the ten cases mentioned above.

4. The suppurative process may gradually pass over into the chronic stage. In case it is limited to the bronchi, bronchiectasis results. If on the other hand, the inflammation is situated in the parenchyma, it may spread and gradually involve more and more tissue, or it may encapsulate and become quiescent with an occasional flare up.

At any time during this acute period danger threatens the patient. How great that danger is depends on various factors, on whether the infection is

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limited to the bronchial tree, or whether it is spreading in the lung parenchyma, also on the virulence of the organism and the resistance of the patient, or whether the suppuration is near the hilus or near the surface of the lung, and on whether blood-vessels are involved in the process. A complication may develop unexpectedly and interrupt an hitherto fairly satisfactory convalescence. A sudden pyopneumothorax may terminate fatally, there may be a severe hemorrhage, a focus of secondary pneumonia may develop, or embolism may result by a fragment being carried by the pulmonary vein to the heart and through it into the general systemic circulation to form a brain abscess or other secondary focus.

It is apparent therefore that alert watchfulness is in order, and that intervention may become necessary at any time. As long as convalescence is satisfactory, and there is slight steady improvement, one should carry the patient along until cure results or to a stage when the acute symptoms have been overcome and the danger of spreading sepsis has been reduced. During this period every measure calculated to favorably influence the condition must be utilized. Due attention must be paid to the general condition of the patient, his age and his habits. Absolute rest in bed is of primary importance, the diet should be calculated to be high in caloric value and easily digestible. Stimulation should be used to strengthen the heart. In all those patients who have a positive Wassermann, salvarsan injections and other antisppecific treatment should be instituted.<sup>7</sup> Spirochætes have frequently been found in the pus of lung abscesses.<sup>8</sup> Whether they are the primary cause of it or are to be considered secondary invaders is not definitely known. It is known though that salvarsan injections at times favorably influence the disease. One should therefore bear it in mind and use it in rebellious cases. Then there is postural drainage, the effect of which is often very striking. The patient himself usually discovers the position favoring good drainage, and one should be guided by him and prescribe emptying of the cavity three or four times a day. In other cases no benefit results from this treatment. If in spite of these measures no improvement takes place, or the condition tends to gradually get worse, some form of more active interference has to be considered. This applies alike to the rather acute cases which do not improve, and to those patients who come under observation after they have reached the chronic stage.

What can be done? In order to answer that question one has to know what one wants to accomplish. Drainage is naturally the one object to be sought, drainage either by way of the bronchial tree or through the chest wall. It is, however, not so easily accomplished as in other parts of the body. One has to consider the respiratory and circulatory mechanism in working out a plan of action, in addition to the element of infection, for anything that is done may seriously embarrass either of these two systems and thereby lower the vital capacity of the patient, even to such a degree that death may ensue.

The first thing to do therefore is to make an accurate diagnosis or as near accurate as possible. A good history is most important. Careful bacteriological examinations of the sputum should be made. Physical signs are known to be often very misleading or even absent. The Röntgen-ray is of the greatest value. One should therefore have good pictures made in different positions, preferably stereoscopic. They will show the extent of the lesion, whether near the front or the back, near the surface of the lung or near the hilus, whether breaking down of tissue has taken place, with a fluid level in the cavity or not. One also learns whether there is displacement

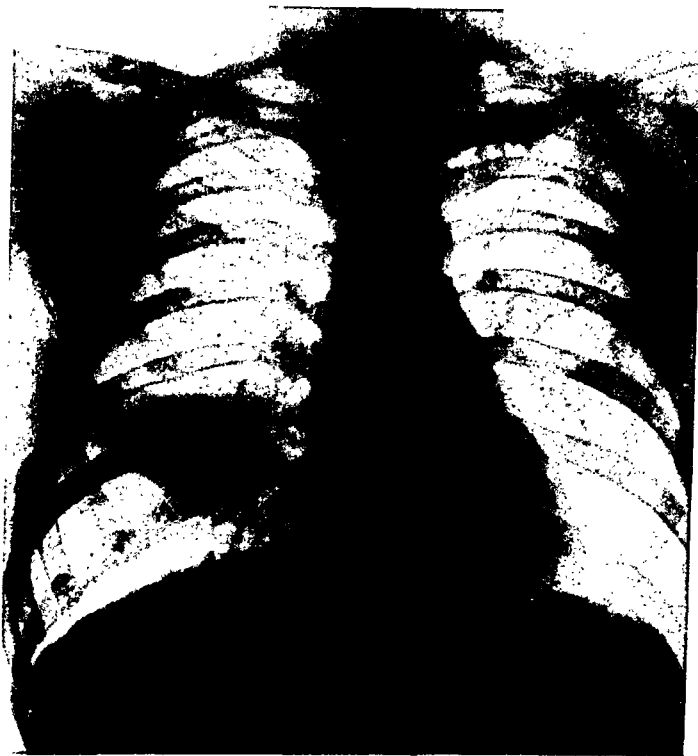


FIG. 3.—Bronchiectasis of right lower lobe of short duration.

of the heart or the presence of an empyema. The greatest aid, however, in addition to the X-ray, is the bronchoscope. By bronchoscopic examination, for instance, we are able to learn definitely from which lobe pus exudes, whether perhaps a tumor of the bronchus or a foreign body is responsible for the suppuration, or whether strictures are present. Above all, however, by injecting the affected lobe with iodized oil it is possible to demonstrate fairly conclusively whether one is dealing with a lung abscess or a bronchiectasis. When all these facts are known, it is possible to work out a plan of action.

At the Lenox Hill Hospital we are so much impressed with the value of bronchoscopy as a diagnostic measure that practically all cases with suspected suppuration are referred to that department. We are very fortunate to have Doctors Kernan and Oberrender in charge of the work, whose untiring efforts and patience have done much to advance our understanding of lung suppurations. It isn't only in diagnosis, however, that advance has been made, but in the treatment of these unfortunate cases. Many patients are admitted directly to that department for purposes of treatment, which may be carried out on ambulatory cases or on hospital patients. Usually a bronchoscopy is done once a week, at which time strictures are dilated, tubes are passed into the affected lobe, tenacious mucous plugs and pus are removed by suction and some antiseptic solution is injected for the purpose of influenc-

of the heart or the presence of an empyema. The greatest aid, however, in addition to the X-ray, is the bronchoscope. By bronchoscopic examination, for instance, we are able to learn definitely from which lobe pus exudes, whether perhaps a tumor of the bronchus or a foreign body is responsible for the suppuration, or whether strictures are present. Above all, however, by injecting the affected lobe with iodized oil it is possible to demonstrate fairly conclusively whether one is dealing

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ing the inflammatory process. Most of the cases included in this paper have had a diagnostic bronchoscopy, and the majority have also been treated for a longer or shorter period. If it is found that the condition in a certain patient is not suitable for this treatment or that operation is indicated, he is referred to the surgical department. This does not mean, however, that all patients who do not promptly respond to bronchoscopic treatment are sent to the surgeons. They are referred only if definite indications for surgery exist. Otherwise the treatment is continued for a long time, even several years, in the hope of favorably influencing the process. This applies of course especially to cases with bronchiectasis of limited or great extent. Conferences are held from time to time with the surgeons to pass on doubtful cases. The impression that has been gained so far is that bronchoscopic treatment is of distinct value, especially in early cases.

The following case is an example of what may be accomplished by bronchoscopic therapy:

CASE III.—L. S., forty-eight years old, came under observation, October, 1924, on account of a hacking cough, loss of weight and strength, but only slight expectoration. There was dulness over the right side of the chest, anteriorly and in the axilla. The temperature was not raised. Tuberculosis was suspected but numerous examinations were negative. The X-ray showed a dense shadow in the region of the right middle and lower lobes, suggestive of a lung abscess (Fig. 5). At a bronchoscopic examination pus was seen to ooze from the right upper bronchus. With rest in bed and prolonged weekly bronchoscopic treatments, the condition gradually cleared up, the patient gained weight, and eventually completely recovered (Fig. 6).

As there is considerable difference in the cases with lung suppuration, it is well to consider the more active treatment under the headings of the three large groups mentioned above.

A. Treatment of Bronchiectasis.—Much depends on whether the case is seen early or late, whether it is limited to one lobe or bilateral in extent. In those cases in which the infection is limited to the bronchial tree, with perhaps small cavities due to dilatation of some of the bronchi, and regardless of whether the surrounding lung parenchyma is infiltrated and fibrosed or not, the object to be achieved naturally is to try and favor drainage by way of the bronchi. Postural treatment is of great help, as all the infected bronchi communicate with the larger trunks. Inhalations to help fluidify the secretion and make it less odorous are of value. This treatment may be supplemented by bronchoscopic therapy. By dilating strictures, cauterizing granulations, and sucking out tenacious secretion one may open up paths for better drainage. It is also possible to inject antiseptic or astringent solutions to favor healing. In the very early cases one may even remove the offending infectious agent which has gained entrance by aspiration, and thus abort the process. Myerson<sup>9</sup> has shown by bronchoscopic studies after tonsil operations that in a large proportion of cases blood is found in the tracheobronchial tree as well as in the pulmonary tract, and concludes that it isn't the aspiration as such which does harm, but the fact that it cannot be expelled in certain patients, owing to some impairment of the expulsive

mechanism. If this is conceded to be true, it is evident that early bronchoscopy aimed at the removal of such aspirated potentially infective material, should cure these cases. Myerson,<sup>9</sup> Meyer,<sup>10</sup> Miller,<sup>11</sup> Jackson,<sup>12</sup> Kernan<sup>13</sup> and others have put this method into practical use and have reported numerous cures.

It is known that bronchiectasis is at first often a localized lesion, and that later one bronchus after another becomes infected, until an entire lung or both sides are involved. It is very desirable therefore to utilize all means to combat the disease in this early stage, and there is at present no method equal to or superior to bronchoscopy.

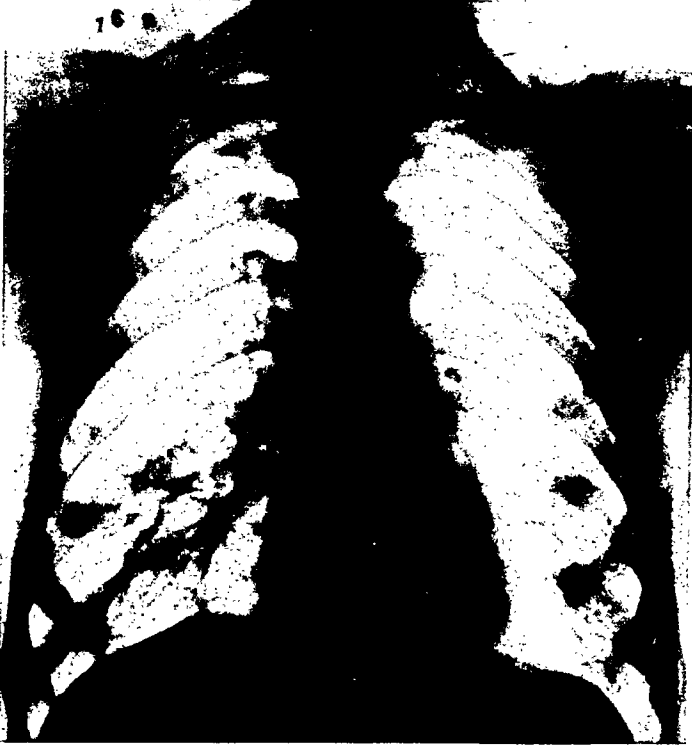


FIG. 4.—Bronchiectasis right lower lobe. Spontaneous cure. X-ray three years later.

If these measures fail, artificial pneumothorax may be tried alone, or in conjunction with bronchoscopy. If we consider that one of the reasons for failure is the inability of the lung to collapse and empty itself owing to the negative pressure in the pleural cavity which keeps it expanded, it is conceivable that compression or collapse will favor drainage *via* the bronchial tree. This method has been tried by a number of authors, and while Küttner,<sup>14</sup>

Lambert and Miller,<sup>15</sup> and Lockwood<sup>16</sup> do not consider it to be of much value. Whittemore,<sup>17</sup> Tewkesbury<sup>18</sup> and Lilienthal<sup>19</sup> feel that at times it may be of help. Like every other method of treatment, it is probably of real value only in the suitable case. It should be used especially in early cases in whom no serious structural changes have taken place in the bronchi. It seems logical that the requirements for success would have to be a free communication with the bronchial tree, that there should be no pleural adhesions, and that the lung tissue surrounding the infected bronchi must be resilient, soft and collapsible. I have described such a case in detail,<sup>20</sup> in which the result was very striking, and in which there appeared to be a selective action, in that after compression or collapse of all the lobes, reexpansion took place only in the normal lobes, while the diseased one remained collapsed permanently. In cases with marked infiltration of the lung parenchyma, sometimes called suppurative pneumonitis, which is inca-

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pable of compression or collapse, the treatment will naturally be of little value. The same applies to old chronic cases with fibrosis.

If no result is obtained, other means to bring about compression of the lung may be resorted to. A phrenicotomy may be performed or finally some form of surgical collapse, so-called extrapleural thoracoplasty. The extent of this would have to depend on the extent of the intrapulmonary lesion. This operation is usually applied in the more chronic cases with extensive unilateral involvement. It does not cure, and some authors have little faith in it, but it often brings about great amelioration of symptoms, and for this reason several writers, notably Hedblom,<sup>21</sup> perform it in suitable cases.

If all these measures fail, is there anything left to do, or should anything else be done? Much depends on the condition of the patient. If he has been improved considerably by bronchoscopic treatment or a collapse operation, if the amount of sputum has been diminished and is non-odorous, the best advice is to be satisfied. If on the other hand there has been no improvement, if the sputum is copious and of a disagreeable odor, making the patient's life miserable and him practically an outcast, some more radical step may be proposed, either a direct approach to the suppurative focus or a lobectomy. The cases in which these operations are indicated are naturally those with a unilateral lesion and preferably those with involvement of only one lobe.

By direct approach is meant an operation *via* the thoracic parietes directly into the suppurating lobe. In true bronchiectasis, as we consider it to-day, a drainage operation would seem to be of little value, because not all affected bronchi can be reached. In actual practice, however, it has been found that a bronchial or pulmonary fistula established in the centre of the lesion may by external drainage and aëration do away with the odor and improve the general well being to such a degree as to almost amount to a cure.

By the gradual destruction of the lobe, as lately proposed by Graham<sup>22</sup> and which he calls cauterization pneumectomy, much may be accomplished. The important points are that the affected fibrosed lung tissue, together with the infected bronchi, are actually destroyed. The reports published so far indicate that we have here a method of treatment giving excellent results with a comparatively low mortality.

It is in this same group of cases, a resistant disabling bronchiectasis, limited to one or two lobes, in which lobectomy is indicated. Graham,<sup>22</sup> Robinson,<sup>23</sup> and others have reported successful cases, and Lilienthal<sup>24</sup> has shown that the results in the patients who have recovered are brilliant. The deterrent factor to-day is the high mortality attending such an operation.

B. Treatment of Lung Abscess.—In cases of bronchiectasis in which the infection has not remained confined within the dilated and sacculated bronchi, but has broken through and invaded the surrounding lung parenchyma in one or more places, bronchiectatic abscesses result. Such perforation may result early and lead to rapidly spreading gangrenous abscesses, especially in those aspiration cases in which putrefactive and pus-producing organisms have

entered. As a matter of fact the bronchiectasis has hardly time to develop before perforation takes place. In other cases the infection remains confined within the bronchi for some time and then a slow perforation takes place and gives rise to a gradually developing abscess. Both these types should then no longer be classed with bronchiectasis, but with the lung abscesses produced in other ways. They should, however, be given the benefit of conservative treatment and bronchoscopic therapy, for it is particularly in this group of acute post-operative abscesses that Wessler<sup>25</sup> reports a spontaneous cure of  $33\frac{1}{3}$  per cent.



FIG. 5.—Lung abscess, right upper lobe. Probably bronchiectatic in character, insidious onset.

In a general way it may be said that the acute type of these abscesses with rapidly progressing destruction of lung parenchyma and liquefaction belong in the same class as acute lung abscesses following pneumonia or embolism, and require the same treatment. Lung abscess proper, meaning by that a collection of pus in the lung parenchyma, originating in either of the ways mentioned above, is a truly surgical condition, and drainage alone will bring about a cure, either by way of the bronchial tree or through

the chest wall. Nature may bring about such drainage by perforation into a bronchus or into the pleura, and thus lead to a cure. If it does not, it is up to the surgeon to establish drainage. At what time in the course of the disease should he intervene? That is a question not easy to answer. I think all thoracic surgeons are agreed that the earliest time consistent with safety is the best time, as it is most likely to lead to complete restitution to normal. Operations done very early during the acutely septic stage of the disease have a very high mortality and should be avoided. Then also one should give nature a chance. If we consider the pathological process within the lung to be a gradually progressing destructive one, as Hartwell<sup>26</sup> has so well described, it is possible to conceive of the process reaching either a large bronchus and breaking into it or the pleura and producing there adhesions to the parietal pleura which makes operation much safer, or an empyema, which according to reported statistics leads to a high percentage of



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cures. Just how long one should wait has to be judged in the individual case. The majority of authors seem to feel that if no improvement or cure has resulted in two to three months, operation should be considered. If at any time during this period the condition gets worse, or the indications are clear cut, operation should be done earlier. No definite rules can be laid down, but it may be said that it is wise not to let a patient get into the chronic stage, because in this period many more complications threaten and a restitution to normal, even after operation, is longer drawn out and often is impossible.

In those cases in whom the lung has become adherent, the entire operative procedure may be carried out in one stage. It is best to resect a piece of one or two ribs, and after making sure of the location by an exploratory puncture, go right in alongside the needle. By means of a finger the opening may be enlarged and all the necrotic material and pus evacuated. If there is much bleeding a tampon should be packed into the cavity, otherwise a soft rubber tube or rubber dam should be inserted. In the more acute cases—those operated on within a few months after onset—one finds an irregular ill-defined cavity, with strands or septa running through it. The amount of pus and necrotic material found in these cases indicates that no free bronchial communication ever existed, at least not of a size sufficient to carry out this material. In case the lung has not become adherent, but the location of the abscess is superficial and has been definitely localized, a circular suture approximately the two pleural layers may be done, and a tampon then lightly packed into the wound for several days, when an opening is made into the abscess within the limits of the circular suture. Instead of a suture, one may simply pack gauze against the pleura which will favor formation of adhesions. More difficulty is experienced in those patients in whom no adhesions have formed. The abscess is usually situated deeply, and not easy to localize. It is necessary to open the thorax, palpate the lung, and after finding the infiltrated area, suture the overlying visceral pleura to the parietal one. It is important to choose the proper place for the incision, so that the abscess comes to lie directly underneath. The procedure carries with it more danger than in the other cases and usually has to be performed under general anæsthesia. For these abscesses difficult to localize, Heuer<sup>27</sup> has proposed a method of approach which is safer than open thoracotomy. He advises stripping the parietal pleura from the thoracic wall over the point of approach as a preliminary step in the drainage operation, and for purposes of exploration. Before deciding on operation one should give these patients every chance to perforate into a large bronchus. The following case, in whom operation seemed indicated, but was advised against on account of the danger involved, and who eventually perforated and recovered, is reported to illustrate this point.

CASE IV.—T. K., thirty-one years of age, was admitted March 25, 1927, complaining of cough, expectoration of blood and pus and foul breath. Onset seven weeks previously with a severe cold. Continued at work. Two weeks later developed sticking pain in the lower right chest, and a few days later cough with expectoration. Cough increased

in intensity and sputum was composed of blood and pus and had a very fetid odor. These symptoms had continued until admission. Physical signs were negative except for little dulness and a few râles in the right axilla. There was 150-200 c.c. of sputum a day, which on culture showed strept-hæmolyticus, strept-viridans, staphylococcus albus, and micrococcus siccus. Repeated examinations were negative for tuberculosis. X-ray examinations showed a dense shadow in the right lower inner zones (Fig. 7). There was no fluid level. A diagnosis of lung abscess near the hilus of the lung was made. Bronchoscopic examination substantiated the diagnosis, but did not improve the condition. Lipiodol injection did not enter the area of consolidation, indicating that there was no large bronchial communication. He expectorated large quantities of pus, began



FIG. 6.—X-ray taken nine months later. Complete cure after several months of systematic bronchoscopic treatment.

to feel better and gained weight. He was therefore discharged in the hope that he would evacuate his abscess completely through a bronchus. Apparently he did develop a good-sized perforation, for two weeks after discharge from the hospital he had a pulmonary hemorrhage with expectoration of much pus. He was readmitted but improved steadily, and the X-ray showed diminution in the size of the shadow. Improvement continued, and an X-ray taken November 16, 1927, showed complete disappearance of the shadow. (Fig. 8.) The patient has gained weight and is able to do his regular work.

In the chronic lung abscesses the danger of sepsis is usually less,

while hemorrhage assumes an important rôle. The surrounding lung tissue is firm and sclerosed, and has lost its elasticity, the bronchi are dilated, rigid and infected, and the blood-vessels friable. There is usually a well-defined fluid level. The lung may be adherent or not. On this largely depends whether the operation should be done in one or two stages. The condition of the patients also has to be considered in deciding this question, for they usually cannot stand very much and care must be taken not to overtax their strength. For this reason alone a two-stage operation offers advantages.

While in the more acute cases healing usually takes place fairly early after operation, it is often long drawn out in the chronic cases, and a bronchial or pulmonary fistula has to be maintained for a long time or even permanently. One reason for this is that old cavities become lined with epithelium which is continuous with that of the bronchi and prevents obliteration. Another reason for delayed healing is found in the lung tissue surrounding the old

abscess cavity, which is infected and contains numerous little recesses filled with material which keeps up a mild suppurative process. The fistula thus acts as a permanent safety valve. Although not ideal, the results of drainage in these old cases are nevertheless so gratifying that the little discomfort is fully compensated for. Lobectomy would be the operation of choice were it not for the high mortality. If the cautery pneumectomy of Graham proves safe, it may be adopted as the method to cure many of these old cases.

After the fistula has existed for months or years, and no longer discharges pus, but simply a little mucus, and the X-ray shows a clear field, one may consider that it has fulfilled its purpose and allow it to close spontaneously, which in many instances it will do as soon as the tube is removed. In some cases, however, there are definite obstacles to closure and one has to operate. Many methods have been proposed, either of which may at times lead to the desired result. Some years ago I reported six cases of persistent bronchial fistula<sup>28</sup> closed with the aid of muscle flaps which remained healed and gave no further trouble.

C. Treatment of Massive Gangrene of Lung.—Knowing the pathology, suggests the treatment of this condition, which is thoracotomy with removal of the necrotic mass. Unfortunately the diagnosis cannot be made unless one operates. The clinical picture is that of an empyema, and at operation for this condition the demarcated lobe is accidentally discovered. This is perhaps an argument in favor of making empyema incisions sufficiently large to be able to look in. The prognosis is not necessarily bad, especially if operation is done fairly early. Cases V and VI mentioned under post-operative deaths belong in this class, and the following case, which was also published as Case VIII, in *Archives of Surgery*, vol. xii, January, 1926, is repeated in detail because it brings out the difference between massive gangrene and so-called gangrenous abscesses.

CASE V.—M. W., a woman, aged thirty-two, was admitted October 31, 1923, complaining of pain and swelling of the right arm and shoulder of eight days' duration. The pain was so severe that she was unable to sleep.

She had had a miscarriage three weeks before. Two weeks before she had a severe chill followed by fever which in turn was followed by pain in the right side of the chest, dyspnoea and bloody expectoration. Eight days before swelling of the right arm and shoulder developed. Examination showed an extremely sick woman with a temperature of 103.2°, pulse 150, and respiration 40. The right arm and shoulder were enormously swollen, red, hard and tender. Fluctuation was present over the entire upper arm, and shoulder motion was restricted. Multiple incisions were made, an enormous amount of pus being evacuated; on culture this showed staphylococcus aureus.

The patient was extremely septic, irrational most of the time and her condition was poor. A blood culture was sterile and the Wassermann reaction was negative. Two weeks after operation it was noticed that the right side of the chest was immobile. The percussion note was flat posteriorly and in the axilla, with absent fremitus and voice sounds. Anteriorly, breathing was harsh and accentuated. An exploratory puncture in the posterior right chest showed thick, foul-smelling pus which on culture grew staphylococcus aureus. On the following day a part of the eighth rib was resected under local anaesthesia. The temperature at this time was 102.6°, respiration 32, pulse 140. The empyema cavity was filled with putrid pus of which about 1000 c.c. was removed.

While evacuating it a large fragment of gangrenous lung, representing from one-fourth to one-third of a lobe, was extruded, exposing a red bleeding surface on the lower lobe of the lung.

Several open bronchi were noted. An iodoform tampon was packed against this bleeding surface and the thorax was then partly closed. The operation did not influence the temperature, for it did not come down until after six weeks. The patient was treated as though she had a regular empyema, and the cavity was gradually obliterated. The small bronchi closed spontaneously and did not prolong the convalescence. The patient was discharged January 16, 1924, about two and one-half months after admission,

in a much improved condition and with the thoracic wound healed. Examination of the gangrenous lung showed necrosis, although the architecture of the tissue and the outline of many of the cells was still preserved. Scattered through the lung were collections of coal dust pigment and here and there clumps of bacteria (cocci). The patient had probably had a septic infarct of the lung from the miscarriage and later desquamation of the entire affected portion of the lung, with secondary development of an empyema. As long as the pus was under pressure in the thorax it kept the necrotic fragment against the lung, but as soon as the pressure was released, it separated, exposing the bleeding surface.



FIG. 7.—Acute lung abscess. Probably post-pneumonic, situated deeply. Difficult of approach.

Of our total cases of 105 only 32, or 30 per cent., were subjected to some form of operative interference, usually a drainage operation in one or two stages. Of these 10 died, or 31 per cent., some soon after operation, others a long time after. These deaths are not all to be classed as operative mortality, however, for operation was in some instances undertaken in patients who were apparently doomed to die of their disease soon, merely in the hope of saving them. In others death did not come until a long time after operation and had no direct relation to it. The drainage operation simply failed to halt the process, and extension of the suppurative focus or a local or distant complication developed just the same. This again demonstrates that if a small pocket of infected material is left behind, an acute flare up may develop at any time. These patients died of their disease, not of the operation. The following are short histories of patients so classed:

CASE VI.—J. K., fifty-two years old, was operated on March 30, 1925, for carcinoma of the sigmoid. One-stage operation was performed. On the following day he had a

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diffuse bronchitis with a temperature of 101.2°. There were loud moist râles over the entire chest, and the finger nails were cyanotic. There was no evidence of pneumonia. It was noticed that the patient had great difficulty expelling mucus and a croup kettle was therefore ordered. Condition gradually got worse. Eight days after operation consolidation could be made out in the right lower lobe, and two days later he had a great deal of foul-smelling sputum. By means of the X-ray multiple cavities could be demonstrated in the right lower and middle lobes. Sputum examination showed diplococci and short chain streptococci with a few Gram-negative bacilli, probably anaerobes. The condition looked hopeless, as the process was progressive, but in the hope of establishing drainage of the principal cavities in the right lower lobe, an operation was done two weeks after onset. The lung was found to be solid, with collections of this foul-smelling pus within the gangrenous tissue. An autopsy showed multiple lung abscesses on both sides. The abdominal condition was perfect, healing having taken place by primary union.

CASE VII.—P. F., sixty-three years old, was admitted March 10, 1926, with a septic temperature and an old neglected intrapulmonary suppuration. About eight months previously there had been a gradual onset with cough, expectoration and loss of weight. Conservative treatment had no effect. Under our eyes the process steadily extended. An operation was therefore done March 25, 1926. A section of the eighth and ninth ribs was removed. The lung and pleura had fused. The lung was entered by excising the exposed portion of thickened pleura and underlying tissue. Pus exuded from numerous channels. Multiple cavities were opened and drained, but this did not halt the process. More and more lung tissue became involved until the entire side was affected. The patient died seventeen days after operation.

CASE VIII.—J. D., twelve years old, was admitted January 17, 1923, with signs and symptoms of lung suppuration on the right side. It had started insidiously about two years previously. Röntgen-ray examination showed a deep-seated abscess around the root of the lung and extending into the right base. As there had been gradual progression in spite of conservative treatment during the last two years, operation was decided on and performed January 27, 1923. Sections of the seventh, eighth and ninth ribs were removed. The pleura was not adherent. Exploration revealed infiltration in the mid-portion of the lung close to the spine. This area was sutured to the parietal pleura and after drainage had been assured, the wound was partly closed. An empyema resulted which was drained through the established wound. On February 20, 1923, the abscess cavity within the lung was opened wide. By breaking or dividing partitions several cavities were converted into one large one, resulting in excellent drainage, with drop in temperature and improvement in weight and general condition. When almost healed, and after having been normal for a long time, the patient developed broncho-pneumonia of the opposite side and died June 2, 1923, four months after operation.

CASE IX.—V. M., thirty-one years old, was admitted June 8, 1927, with a suppurative lesion of the right lung, associated with a temperature of 104. He complained of pain in the right chest and expectorated 200–400 c.c. of foul-smelling pus in 24 hours. He stated that his trouble had started six months previously with an attack of pneumonia which confined him to a hospital for three months. After discharge the cough had persisted and he had lost 25 pounds in weight. About a month before admission his condition had become worse, he had developed severe pain in the side and the sputum had increased in amount. His breath was foul. The sputum showed anaerobic Gram-positive diplococci. X-ray showed a cavity within a consolidated area in the right upper chest. Indications for operation were clear. June 14, 1927, operation: Incision posterior to scapula. Resection of a segment of the fourth and fifth ribs. Thick adherent pleura found. Exploratory puncture immediately followed by incision of a large cavity filled with pus and necrotic material. Large soft drainage tube inserted. Culture of pus

showed pneumococcus, non-hemolytic streptococci, micrococcus siccus and staphylococcus albus. After operation his condition improved considerably, temperature came down, and sputum was reduced to 25 c.c. in 24 hours. Then, unexpectedly, on July 6, there was a chill with a rise of temperature to 107.8. The chest signs were unchanged and the cause of the temperature could not be determined. It was assumed to be an extension of the process in the lungs. There was no vomiting or other complaint. The abscess cavity was clean and by means of a good-sized bronchus in the depth there was good aeration of the lungs. Four days later there was another chill with temperature to 108. Salvarsan injections had no effect. Blood culture was sterile. He gradually became somewhat jaundiced, which we at first attributed to the effect of salvarsan, but when he also developed tenderness over the epigastrium, metastatic abscess of the liver

was considered. He was too sick to have anything done, and after a few more chills he died July 15, 1927.

CASE X.—A. A., forty years old, was an old neglected case of gangrene of the lung with a contracted empyema drainage opening. The condition had existed for months. There was retention of pus which surrounded a completely demarcated and separated lower lobe of the right lung. The patient was in a septic state. An attempt to establish better drainage and to remove the necrotic lobe resulted in death. She died in spite of the operation, not because of it.

CASE XI.—M. S., forty-three years old, was admitted March 3, 1927, complaining of cough and foul expecto-



FIG. 8.—Cure by perforation of the abscess into a large bronchus. X-ray taken eight months later, complete disappearance of shadow.

ration since November, 1926. There had been a gradual onset of a respiratory condition in the early part of October, 1926, consisting of cough, pain in the lower chest, and fever. Cough gradually became worse and the sputum foul-smelling and larger in amount. He was finally sent to a hospital for bronchoscopic treatment and after about two months was discharged improved. While in the country his condition became worse and he was sent to our hospital. He had signs which were attributed to a lung abscess of the right lower lobe. Repeated sputum examinations were negative for tuberculosis. The Röntgen-ray showed marked density of the right lower lobe with a cavity. Bronchoscopic treatment had no effect and surgical consultation was requested. Operation March 30, 1927: Resection of 10 cm. of the ninth rib. Thick-walled empyema cavity entered which contained foul pus and a large gangrenous fragment of lung tissue. After removing this a large cavity, the size of an orange, was found in the lower lobe. It had a gangrenous lining. There were numerous bronchial openings. A section of tissue was excised from the margin of the cavity for diagnosis. In spite of excellent drainage the temperature did not come down to

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normal and the patient gradually failed, and died May 1, 1927, of a general pulmonary tuberculosis. The fragment excised showed suppurative lung tissue and tuberculosis.

In only four of our cases can we actually speak of a post-operative death, in that it was the direct result of an operation deliberately undertaken to cure the condition. These patients could have perhaps continued their miserable existence a little longer, but none of them could have been cured without operation. As a matter of fact prolonged conservative treatment had been tried in three of them. They represent a true post-operative mortality of 12 per cent. The following are brief histories of these cases:

CASE XII.—H. L., twenty-one years old, was admitted August 3, 1923, with a history of having had a tonsillectomy performed nine months previously. This was followed by illness which gradually got worse, resulting in high fever two months later, and at a somewhat later time, increased cough and expectoration of foul sputum. At times there were hemorrhages. She was an anæmic, chronically ill patient. There was marked clubbing of the fingers. She had involvement of the right upper and middle lobes with three cavities showing on X-ray. An operation was done under local anæsthesia. A portion of the second and third rib was resected anteriorly. The pleuræ had fused. The lung felt hard. An exploratory puncture showed thick foul-smelling pus. Cavity entered at once and pus and necrotic material was evacuated. The cavity communicated with two others. All three were converted into one, and an iodoform tampon lightly packed into it. The patient stood operation well. The next day her condition was fair, but on the following day she suddenly became worse and died, apparently of an embolus. The pathological report on excised tissue was chronic suppurative lung tissue.

CASE XIII.—S. S., fifty-four years old, had a cholecystectomy performed December 22, 1926. She developed a pulmonary complication which eventually resulted in a lung abscess, giving typical clinical and laboratory evidence. Operation was performed January 22, 1927, one month after her gall-bladder operation. Section of the fifth and sixth ribs was removed and an exploratory puncture done showing foul pus. A tampon was placed against the pleura and the patient returned to bed until the second stage of the operation three days later. At this time pus was seen to exude from the old puncture wound. The abscess was opened and thin foul pus evacuated from a lobe which was diagnosed as suppurating pneumonitis with gangrene. She died the same day of continued sepsis.

CASE XIV.—F. S., eighteen years old, had a history extending over ten years. Every conservative treatment had been tried, including bronchoscopy and artificial pneumothorax. There had also been two unsuccessful operations. There was involvement of the left lower lobe. The sputum contained short chain strept and a facultative anaërobe. Operation was performed October 29, 1925, with resection of a portion of the seventh, eighth, and ninth ribs. The pleura was not opened at this time. After this simple first stage she coughed more than before and the sputum increased in amount. She developed signs at the opposite base with bronchial breathing and high fever. After temperature had been normal for a while, the second stage was attempted on November 19, 1925. The lung was found adherent, it had a leathery feel. Punctures were negative. The patient took gas oxygen poorly and the operation had to be discontinued. She died the following day with marked cyanosis and dyspnoea.

CASE XV.—E. C., thirty years old, was admitted April 6, 1923, with a suppurative lesion of the right upper chest which had immediately followed upon the incision of an alveolar abscess with extraction of a tooth under general anæsthesia, one year previously. She was very sick and had all the typical signs and symptoms of lung suppuration. Operation was indicated and performed May 25, 1923. A portion of the second, third, fourth and fifth ribs was removed anteriorly. Three good-sized cavities were found.

The intervening tissue was removed and the cavities converted into one. Wound left wide open. Patient made a nice recovery and was discharged much improved with a clean wound June 19, 1923. Improvement continued for several months and then there was a sudden flare-up which necessitated readmission to the hospital. Lobectomy was decided on. Operation was performed October 29, 1923. The right upper lobe was resected without much difficulty. The operation was well borne and the patient recovered nicely, until the evening of the following day when she became cyanotic and expectorated bright red blood with each spell of coughing. She died in spite of all efforts to save her. The autopsy showed bronchiectasis and associated pulmonary tuberculosis of the remaining right middle and lower lobes. The cause of death was pulmonary embolus, the large embolus extending from the pedicle of the upper lobe down the pulmonary artery into the right heart and also up into the left branch of the pulmonary artery.

Of the patients who recovered after operation, twenty-two in all, seventeen are cured and five are classed as improved, of which four have a bronchial fistula. In one of these the fistula is ready to be closed, in another it will probably close spontaneously as soon as permitted to, and in two it will have to remain permanently.

Of the patients not operated on, sixteen died at the hospital. They were admitted because of their suppurative process, or for the primary disease of which the lung suppuration was a complication, or for complications such as secondary pneumonia, embolus, cardiac failure, etc., the result of long-standing suppuration. Two complicated a carcinoma of the oesophagus, one a carcinoma of the larynx, one a carcinoma of the tongue, and one followed a fracture of the jaw. Another case with multiple lung abscesses had a convulsion during bronchoscopy and died of brain embolus. The other ten patients were chronic cases in whom the etiology could no longer be definitely determined. Autopsies performed on some of them showed multiple degenerative lesions of other organs and usually multiple abscesses of the lungs.

All the other cases, those not operated on and those who did not die at the hospital, were either on medical treatment alone or combined with bronchoscopic therapy. There were fifty-seven such patients. Of this number ten are at present under treatment, while the remaining forty-seven are divided as follows: Twenty-one have been discharged as cured, eleven have been discharged as improved, fifteen have been discharged as not improved, of which a few have since died. The most gratifying group are naturally those discharged as cured. Among them were very striking cases with well-developed abscesses which either perforated into a bronchus and discharged that way, or were treated bronchoscopically by suction and instillation. There were, however, also very interesting cases of bronchiectasis which had not advanced far and had no serious structural changes, so that they were accessible to bronchoscopic treatment.

Those discharged as improved were much less satisfactory. Some have been followed, others have drifted away as clinic patients which a chronic illness are apt to do. It is therefore not possible to say whether they had recurrences, whether they were eventually operated on, or whether they died.



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The majority showed so much improvement during the period of observation that operation was not indicated. Their condition had been improved to the degree that life was at least temporarily more bearable. It is well known that among those called improved an acute exacerbation may develop at any time, and that even among those classed as cured there are at times recurrences. The only real way to cure these chronic suppurations seems to be actual eradication of the suppurative lesion. Nevertheless, in view of the present high mortality we have not felt justified to subject all these patients to a radical operation. On the basis of experience gained so far, we rather feel inclined to continue the method now in use at the Lenox Hill Hospital, of referring all cases to the Bronchoscopic Department for diagnosis, and possibly for therapy, and instituting surgery only in those cases in which there is a definite indication. There is no danger, or practically no danger in bronchoscopy when done by an expert. The only danger to the patient may conceivably be holding him in that department too long, until a time that the process has become chronic, but that is easily obviated by regular conferences. The aim of all those interested is not to hold a patient, but to cure him.

The most unfortunate group is that composed of chronic bronchiectasis cases with bilateral involvement. In spite of prolonged treatment and by the use of every method known, these patients continue to present the most difficult problems. The aim should be to cure these patients before they reach this stage.

A study such as this demonstrates that non-tuberculous intrapulmonary suppuration is compatible with life, even for many years. How miserable that life will be depends on the extent of involvement, the patient's habitat and his mode of living, the amount and odor of sputum, and the condition of other organs. Patients who live an outdoor life are likely not to feel the ill effects as much as those living in close quarters in the city, and they are not so likely to be obnoxious to their surroundings. They eventually succumb to their affliction, be the immediate cause directly traceable to the local lesion, such as hemorrhage, or extension of the process in the form of a broncho-pneumonia or multiple abscesses, or a pulmonary embolus; or to the degenerative effect of long-continued suppuration on other organs with general exhaustion, or finally to distant complications such as brain abscess, meningitis, or liver abscess.

It would seem that unless conservative measures bring results in the acute cases in a reasonable time, some form of operative treatment is indicated, which in the abscess cases is drainage in one or two stages, and in the bronchiectasis cases, bronchoscopy alone or combined with artificial pneumothorax.

In the chronic cases drainage alone is indicated in those cases in which a cavity can be demonstrated, but in the other cases one is almost forced to the conclusion that some form of operative intervention which aims at the actual destruction of the involved lung tissue, or removal of the lobe, is the only means to bring permanent cure.

On the basis of the results shown, this paper is evidently not presented for the purpose of reporting a large series of cases with an unusually low mortality or morbidity, or to advocate one special form of treatment, but rather for the purpose of calling attention to the tragic outlook of patients with intrapulmonary suppuration. It is hoped that it may stimulate interest in this subject to the end that measures be taken to avoid the large number of post-operative cases, and that a better understanding of the pathology of the disease, with the mechanical factors involved in thoracic surgery, be brought about. In this way it is hoped operative measures, properly timed and executed, will eventually lower the appalling mortality and make it possible for a larger number of these unfortunates to survive and to lead a life free from the distressing symptoms with which they were afflicted.

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# OBLITERATIVE OPERATIONS FOR MASSIVE EMPYEMA\*

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THE object of all operations for empyema is the obliteration of the cavity. This may be accomplished by securing the reëxpansion of the lung by decortication or, more certainly and safely, by eliminating the rigidity of the cavity walls, diminishing the arc or curve of the bony parietes, and apposition of the relaxed parietal with the visceral surfaces of the affected pleural space. The obliteration takes place by fibrosis beginning in the angle of reflection and not between the apposed surfaces of the pleura.

To appreciate the difficulties that may interfere with successful obliteration, one must understand not only the factors which cause the empyema, but also those that prevent closure of the cavity.

The factors which may interfere with closure are:

(a) Of chest wall: Abscess, cellulitis of the skin or soft parts; necrosis of the rib; a rigid or osseous ring at the site of a drainage orifice; rigidity or peculiar structure of the bony chest wall; fusion of adjacent ribs.

(b) Of the pleura: A thickened, fibrous, rigid parietal or visceral pleura; long, tortuous, rigid sinuses leading to remote foci within the lung or pleural cavity; irregular, multilocular, encysted, inadequately drained intrapleural or interlobar empyema cavities; adhesions which withdraw, compress or bind the lung in an abnormal position; thick pus mixed with air, blood, fibrin, or sloughs; foreign bodies, pieces of tubing, gauze or fragments of bone.

(c) Of the lung: Pulmonary abscess or cavity, bronchiectatic cavities, especially those with small pleural openings or granular tracts; pulmonary or bronchial fistulae.

The lung covered by a thickened, infected, chronically inflamed fibrous pleura is progressively compressed, its elasticity is lost or compromised to an irretrievable degree. The infection may extend into the parenchyma of the underlying lung or into the interlobular septa for a considerable depth. This may impede or forever render the lung incapable of reëxpansion to even approximately fill the thoracic cavity.

Early thoroughly controlled closed drainage must be instituted, to prevent the pleural surfaces exposed in an empyema cavity from becoming covered with a thick plastic exudate which, later, organizes forming a compressing fibrous membrane or thick tethering adhesions. This means as soon as aspirations have become ineffective or the exudate frankly purulent.

Open drainage is a menace and is to be avoided, except in localized encysted empyemas, in children, in women and in those with elastic thoracic walls.

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\* Read before the Western Surgical Association, December 8, 1927.

## OBLITERATIVE OPERATIONS FOR MASSIVE EMPYEMA

Secure a rapid and as great a diminution of the cavity as possible and a maximum reëxpansion of the lung by early, conscientious practice of resistive breathing, positive intrapulmonary pressure or intrapleural negative pressure.

Sterilization of the cavity is lessening the virulence of the infecting organisms. Sterility of the fluid contents does not imply freedom of the tissue walls from bacteria. A residual cavity may, and frequently does, become reinfected with bacteria from the walls. The greatest degree of avirulence is secured by thorough drainage.

Irrigation may be combined with drainage. Bland solutions are quite as efficient as antiseptic solutions which are unsatisfactory. Dakin's solution, while not primarily antiseptic, when properly used has an advantage possessed by no other. The virtue of Dakin's solution as a cleanser is due largely, if not solely, to its proteolytic property. This proteolytic action liquefies fibrin, plastic lymph, non-viable and dead tissue. By removing this débris, bacteria are deprived of a fertile media. The viable tissue and body fluids are given an opportunity to develop resistance to and may overcome bacterial growth. The part then is in much better condition for any necessary operation (Graham<sup>1</sup>).

Dakin's solution, due to its proteolytic action, is a chemical decorticating agent of considerable potency. By chemical decortication a surprising degree of reëxpansion may be secured (Graham<sup>2</sup>). Irrigation with chlorinated solution in cases with bronchial or pulmonary fistulæ is irritating to the bronchial mucous membrane and is contra-indicated. Recently occluded bronchial fistulæ may be reopened by liquefaction of the occluding plug.

The mechanical or operative removal of the contracting fibrous membrane by the decortication operation of G. R. Fowler<sup>3</sup> and Délorme<sup>4</sup> may, in rare instances, be of advantage. Délorme opened widely between the ribs and decorticated the lung. He called attention to the importance of the costo-vertebral groove by stating: "The essential to success is freeing the lung to the costovertebral groove." When the possible pathological changes in the underlying lung are considered, it is readily seen that a good result with a functioning lung is exceptional.

When the purulent exudate cannot be controlled, when the condition of the lung and pleura are such that a reëxpansion to fill the chest is no longer possible, then the chest wall must be contracted to meet the compressed lung.

All obliterative empyema operations are extensive and deforming. Frequently they are multiple, each succeeding step is more difficult and formidable than its predecessor. The debilitated state of many of these patients justifies, yes, often demands multiple stage operations. A sequence of operations is made necessary by the lack of a thorough pre-operative understanding of the intrathoracic conditions.

Given a case of empyema that has resisted early proper treatment, or one that has been neglected, the size, shape and topography of the cavity, the intrapulmonary condition, the trend and character of the ribs must be known before undertaking any operation. This will determine the site,

number and length of the ribs to be removed. A meticulous study of röntgenograms of different densities will give valuable information as to the condition of the lung, pleura and ribs. Röntgenograms taken in the erect, the horizontal and two lateral positions after the injection of some fluid contrast media, by completely delineating the cavity, will be of additional advantage (Hegner<sup>5</sup>). Small unsuspected pulmonary fistulæ may be detected by the patient tasting the injected fluid. A 15 per cent. aqueous solution of sodium iodide is a satisfactory non- or slightly irritating contrast media.

The cavity, except in distinctly localized or encysted empyemas, frequently extends into and up the costovertebral groove. This is not uncommon in massive empyemas. Empyema involving the costovertebral groove cannot be obliterated by any of the usual rib operations.

Regardless of the importance of the costovertebral groove, the usual operations, by incisions in great variety of shape, trend and number through skin and soft parts, are all made with a view of removing segments of ribs from the lateral aspect of the chest. This method of direct approach to the empyema cavity ignores the fact, that removal of short segments posterior to the angle of the rib secures a much greater degree of collapse than the removal of long segments anterior to the angle. The collapse is as marked on massive anterior, on lateral as on posterior empyemas and those extending into the groove. Removal of posterior rib segments is the only method which can diminish or obliterate posterior empyemas.

The indirect approach through a straight or slightly curved paravertebral incision exposes the angles of the ribs. It gives easy access for removal of the segments posterior as well as any desired length anterior to the angle. The deribbing must extend well beyond the limits of the cavity.

The closed operations, of which Estlander's<sup>6</sup> is the prototype, remove subperiosteal rib segments from the lateral aspect of the chest. Even though the segments are long, the degree of collapse is often inadequate. Quénu,<sup>7</sup> in 1892, through a U-shaped incision mobilized an extensive flap of ribs and intercostal muscles of the lateral wall. He failed to obliterate the cavity.

The open operations follow the lead of Boekel,<sup>8</sup> who after the removal of long segments of ribs, found the parietal pleura so tense, rigid and thick that it prevented obliteration. He made a cross-incision through the pleura, fashioned flaps which he compressed and held in place by large sponges. Boekel inaugurated the idea of flaps to secure obliteration. Though he accomplished closure, he recognized the necessity of extensive resection, going as far back as his L-shaped incision permitted.

Schede<sup>9</sup> and others, by direct attack, remove the ribs with the intercostal muscles and nerves which form the outer wall of the cavity, doing an unroofing operation. The large fenestra is covered as completely as possible by replacing flaps of the skin and superficial muscles. This unroofing of the cavity, especially if it be extensive or deep, entails a useless sacrifice of tissue. It is undesirable in its immediate and remote effects. The large granulating surface is slow to heal, the discharge of serum and pus debili-

## OBLITERATIVE OPERATIONS FOR MASSIVE EMPYEMA

tating, requires prolonged expensive dressings. Frequently, difficult plastic operations are necessary to close the defect. The completely deribbed area does not regenerate bone, it is unprotected. If very large and unsupported, respiration may be embarrassed and the underlying viscera endangered.

De Cérenville<sup>10</sup> attempted to obliterate pulmonary cavities in the apex of the lung by removing segments of the upper ribs, including the first, from the front. The cause of his failure was the fact that the posterior ends of the resected ribs remain rigidly fixed in an extended position.

Bouveret,<sup>11</sup> though he removed the ribs laterally, states: "Encysted empyemas are more common in the rear. The resistance of the costal arc is more pronounced in the posterior half than in the anterior half."

Therefore, it is logical that a more effective mobilization of the chest wall can be secured by removal of segments of the ribs posterior to the angle as close to the spine as possible.

The inherent tendency of the rib is to spring outward. The outward spring is increased by contraction of the auxiliary muscles of respiration which are inserted into the anterior and posterior segments. When ribs are resected from the middle or lateral aspect of the chest wall, this outward spring is opposed from within only by whatever adhesions that may be present. Tension of adhesions from the rib stumps to the front and sides pull the lung farther away from the costovertebral groove, where adhesions are less extensive and the purulent residue is greatest. This increases rather than diminishes the size and capacity of the groove.

When a rib is resected in its middle area the normal elasticity is expended in the unopposed anterior and posterior stumps. They spring outward, lose their normal obliquity and assume a more horizontal position. Rigid buttresses consisting of an anterior and posterior row of stumps are formed. These buttresses interfere with rather than facilitate approximation of the chest wall with the retracted lung.

Boiffin,<sup>12</sup> November 17, 1894, after studying all previous operations for empyema, performed the first paravertebral thoracoplasty for collapse of an empyema cavity. Most of his predecessors recognized the importance of removing the posterior segment. On account of anatomical difficulties, fancied or real, none except Wagner,<sup>13</sup> 1886, attempted the approach from behind. The Boiffin type of operation has been popularized by surgeons collapsing the chest wall for unilateral pulmonary tuberculosis.

A long straight or curved paravertebral incision is made about two and one-half inches from and parallel to the spinous processes. The spinal muscles are retracted backward and the scapula is retracted upward and forward. A subperiosteal resection of the necessary number and length of ribs is made flush with the transverse processes of the corresponding vertebrae of each rib. The most acute arc of the rib is removed. The cavity is not opened, provision for necessary drainage is made in the most dependent angle. No horizontal rigidly fixed posterior rib stump remains to interfere with obliteration. Greater and more uniform collapse can be obtained by

resecting short segments of ribs posterior to the angle than can be secured by resecting much longer segments of an equal or a greater number anterior to the angle. The downward and inward sinking of the chest wall is more effective than lateral compression. The pliable anterior segment is easily compressed and held inward by suitable dressings until bony regeneration takes place. The entire outer wall is retained, the ribs regenerate in tile-like obliquity, furnish support and protection. Prolonged dressings of large granulating surfaces incident to unroofing operations are seldom necessary. The incision can be so placed that it will not traverse the region of the necessary drainage tube. Infection of the wound is less probable and more easily controlled should it occur. The pleura may be opened as widely as desired for any intrapleural procedure that may be deemed advisable and resutured with ease. The scar and deformity is less conspicuous, obliteration of the cavity, lateral, posterior or costovertebral, is more rapid and the post-operative care is less irksome.

In empyemas of considerable size, those extending posteriorly and into the costovertebral groove, more especially those complicated by pulmonary fistulæ, the indirect or posterior approach by paravertebral thoracoplasty is the operation of choice.

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# POSTERIOR MEDIASTINAL ABSCESS FOLLOWING SUPPURATIVE ARTHRITIS OF CERVICAL VERTEBRÆ

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MEDIASTINAL suppurations are rare, but when present are very serious complications and most often fatal. A thorough review of the literature shows there has been a good deal of discussion about the subject, but there are very few cases reported as cured by operative interference. It seems worth while adding a report of a successful case of this type to the relatively small number already reported.

*Classification.*—In general the origin of mediastinal abscesses have been thus classified:

(1) *Throat and Pharynx.*—Suppuration of peri-tonsillar origin and retro-pharyngeal abscess when due to a very virulent organism often make their way into the chest by direct extension and show very little local symptoms.

(2) *Structures of Neck.*—The superficial suppurations in the neck most always localize and are drained to the surface, but the deep inflammations behind the

fascial planes tend to gravitate toward the mediastinum. This type usually follows inflammation of the deeper cervical nodes and in malignant diseases of œsophagus secondarily infected.

(3) *Operations on Œsophagus, Larynx and Trachea.*—Surgical treatment of most neck conditions is practically free from deep infection, but

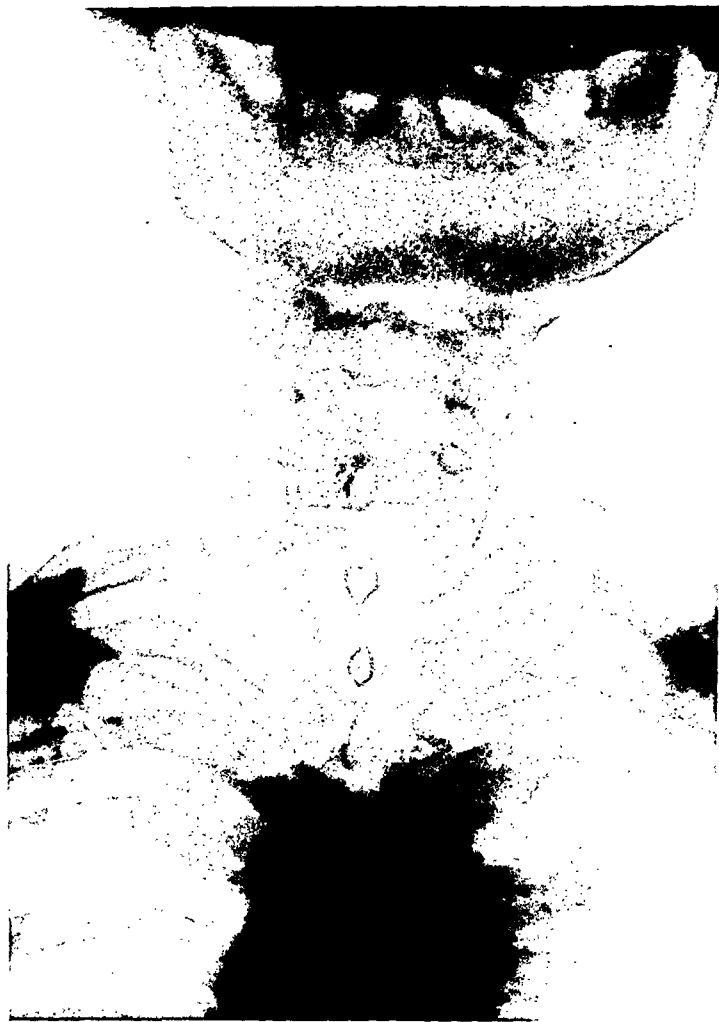


FIG. 1.—X-ray shows bone involvement between fifth and sixth cervical vertebra.

operations for removal of larynx and œsophageal diverticulæ are most often associated with fatal mediastinal abscess.

(4) *Structures of Mediastinum*.—Acute infection either local, or by the blood stream, of the lymph-glands of mediastinum or surrounding tissues may end in suppuration. A liquefaction of a chronic tuberculous process may give signs of pressure with secondary infection by pyogenic organisms. There are cases, which are attributed to spondylitic abscess of the dorsal

vertebra, caries of ribs or pleural infection and malignant degeneration.

(5) *Traumatic*.—All wounds to the organs of the thoracic cavity may lead to mediastinal suppuration. The suture of stab wounds of the heart by a spectacular operation, only to have the patient succumb to infection over which there is very little control.

*Clinical Classification*.—Acute abscesses of the type under discussion occur at any age, but cases reported are mostly in men (85 per cent.). The cases reported in children were of tuberculous origin due to spinal caries.

The symptoms are not distinctive. The pres-

FIG. 2.—The sinus has been injected with bismuth, which shows tracts leading to diseased area and also toward chest cavity.

ence of a suppuration about the neck or operative procedures on œsophagus should be considered in relation to potential chest involvement, for most cases, whether the abscess is small or large, there is discomfort and actual pain in the posterior chest, about the shoulders or may even radiate to the abdomen. Dyspnœa and cough may be complained of due to pressure on the intrathoracic organs or nerves.

*Diagnosis*.—The physical signs may be extremely indefinite and great difficulty encountered in making a diagnosis. The patients are extremely sick and pain is usually of throbbing character. The acute cases are associated with fever, chills and sweats. A pulsating tumor may be noticed at the sternal notch.

There is hardly any chest condition which so tests the acuity of the diag-

nostician. Percussion always reveals dulness to either side of the spinal column, while the anterior chest is resonant. Auscultation is not so important. The interpretation of the pain in my own case was extremely difficult as it was referred to the liver region and X-rays show diaphragm elevated on the right side, which made the suspicion of subphrenic abscess very great. The diagnosis can always be settled by the *exploratory puncture of the mediastinal cavity*, associated with a thorough röntgenological examination of the thorax. The laboratory findings do not throw much light on the subject, because of the co-existing presence of a primary known suppurating focus in the body.

*Treatment.* — The ideal treatment of course as soon as the diagnosis is established is surgical. Guadiani has classified the cases in an excellent article as follows: "*The abscess which gravitates not lower than the fifth dorsal vertebra can be successfully drained by a cervical mediastinotomy, while all others should be approached by rib resection through the dorsal route.*" This latter approach has been admirably described by Lilienthal in 1923 with a report of his case.



FIG. 3.—X-ray of chest before operation shows diaphragm elevated on right but costal angle not obliterated. The aorta and heart pushed to left, while there is marked increase in density behind the sternum throughout the chest.

#### CASE REPORT

The patient was a man, fifty years of age, whose general health had always been good. He had had the usual diseases of childhood and the past history otherwise did not seem significant. He had periodic examinations by his family physician and urine examination was always negative for sugar and albumin. His usual weight was 196 pounds.

About September 20, 1926, without any apparent trauma he developed an area of tenderness, redness and swelling, associated with fever, in the left lumbar region. Within a few days all the signs of a carbuncle of the back were apparent. This was excised and drained; the culture of the evacuated pus being *Staphylococcus albus*. The wound responded to treatment and daily dressings. The patient was free from symptoms.

The first part of December, 1926, when the wound was almost healed, he developed

a temperature as high as 106 degrees. There was pain in the left ear and slight rigidity in the left neck, but no definite localization of pus. The symptoms and signs of septicæmia were present and was proven by blood culture, which was positive for *Staphylococcus albus*. Ten days following onset of symptoms an abscess in the left ear was incised and a few days later signs of an abscess behind the left sterno-mastoid muscle made an appearance and was immediately drained. X-ray at this time revealed a destructive arthritis between the fifth and sixth cervical vertebra. The patient from then on had an extremely stormy time. The temperature varied for 101° to 106°

daily. The wound in the neck seemed to be draining satisfactorily, but it was noted when drainage was slight the temperature was at its peak. There were no signs of foci about the body. Patient was given many transfusions of immunized blood, which seemed at times to check the fever. Further operative procedure did not seem to be indicated at this time.

In April, 1927, because the patient had developed signs of a chronic infection with daily rise of temperature, associated with varied muscular and articular pains, it was decided to fill the sinus in the neck with bismuth paste for a period of six weeks, with the object of keeping the sinus tract open. Following each injection of bismuth the patient had a severe reaction. After the last injection of bismuth, X-ray shown in (Fig. 2) was taken. From then on the patient became acutely ill



FIG. 4.—X-ray of chest five weeks after operation, showing resection of rib on left, the heart in normal position and no increased density in the chest. The diaphragm is much lower than Fig. 3. No collapse of lung.

again, developing pain in the chest and right abdomen. The patient was then referred to the Ruptured and Crippled Hospital, with the view of having an operation on the focus about the cervical vertebrae.

On August 15, 1927, the patient was admitted to the Third Surgical Division under my care and at the time presented a striking picture. He was acutely ill with a temperature of 103°, pulse 100 and respiration 24, and all evidences of a chronic infection, supra-imposed, such as emaciation (102 pounds, although 6 feet 1 inch tall), clubbing of fingers and contractions of the joints. He complained of throbbing pain about the right shoulder and liver region. There was a slight non-productive cough.

Examination at this time revealed a slight lateral deformity of the neck and a small sinus with slight discharge in the neck above the left clavicle. A probe was inserted and the end came in contact with bone. There was no sign of abscess in this region. There was a large healed scar in the left lumbar region, which was the result of a

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primary suppuration. To observation the examination was otherwise negative, except for slight contractions about the joints and the clubbing of fingers as described before. Thorough examination of all regions was negative except for the thorax.

X-rays of all bones and joints showed no pathology except the cervical region (Fig. 1), in which is shown the loss of substance between the involved vertebra. The bone destruction and bone production is pathognomonic of a previous pyogenic process.

Laboratory examination revealed a blood count as follows: Hæmoglobin, 71 per cent.; red blood-cells, 4,160,000; white blood-cells, 11,200; polymorphonuclears, 69 per cent.; lymphocytes, 28; transitionals, 3 per cent. There was no anisocytosis or poikilocytosis. Blood culture proved to be negative. The urine was normal except for a slight trace of albumen. There were no organisms in the urine.

The thorax seemed to be the seat of pathology but presented an extremely difficult picture to interpret in a case which had been ill so long. The chest was well formed and there was no asymmetry. Expansion on both sides was good. To percussion the heart dulness was increased outward. The anterior chest was resonant. There was dulness to each side of the vertebral column for about 6 cm. laterally, pear-shaped, and extending from the third dorsal vertebrae to the eighth dorsal vertebrae. The liver dulness was markedly increased both upward and downward. Auscultation showed the heart sounds regular and forceful. There were no signs of consolidation in the chest by breath sounds.

X-ray of chest (Fig. 3) showed no collapse of the lung or consolidation, but the shadow behind the sternum was increased. The heart was pushed to the left. The diaphragm was elevated on the right but the costo-diaphragmatic angle was not obliterated.

At this time Dr. J. Ralph Scott was called in consultation and the physical examination of the thorax by Doctor Birrell, Reading and myself, was verified. Chest aspiration in mid-axillar line on both sides was negative, except for a small amount of fluid, which to cell count was normal and to bacterial culture was negative. We assumed at this point that there was a definite pathology in the mediastinum but still the pain in the liver region, slight tenderness and elevation of the diaphragm certainly pointed indefinitely to a subphrenic abscess. A long, fine needle was thrust into the area of dulness, posterior on the right side of the chest between the sixth and seventh ribs, close



FIG.5.—X-ray of cervical region, ten weeks after operation, showing marked attempt at consolidation of fifth and sixth vertebra with new bone production.

to the vertebral column. The mediastinum was entered and purulent material withdrawn which revealed culture of *Staphylococcus albus*.

*Tentative Diagnosis.*—Abscess of posterior mediastinum which had gravitated from suppurative process in the neck following injection of cervical sinus with bismuth; but a subphrenic abscess, origin of which either by direct extension or metastatic, had to be also considered.

*Operation.*—September 2, 1927, under local anæsthesia, about five inches of the seventh rib on the right side was resected close to the spinal column. The pleura at this point was œdematous and slightly thickened. The pleural cavity was accidentally broken into but revealed the lung not collapsed and free from fluid. By careful dissection the posterior mediastinum was opened, which brought forth about one litre of purulent fluid. Rubber dam drains were inserted in the wound leading to the mediastinum and also the right pleural cavity was drained, because I felt, due to the already diseased and injured pleura, it would become secondarily infected and thus necessitate a second operation.

The patient stood the operation well, and on the third day his temperature became normal and remained so. The throbbing pain in the chest disappeared and to our surprise the symptoms about the liver region vanished. The wounds drained profusely at first, but by the fourteenth day post-operative, all drainage had subsided and tubes were left out of the wound. The sinus in the neck immediately healed. The wound in the chest healed completely on the thirty-fifth day. At this time X-ray of the chest (Fig. 4) showed a striking comparison with previous chest picture (Fig. 3). X-ray of the cervical region (Fig. 5) shows the healing process about the involved vertebra with very little deformity.

The problem at this time with the patient was to restore his muscular system to normal, which after a year's illness is no small matter to cope with and is almost as serious as the original ailment. Three weeks following the drop of temperature the patient was daily subjected to phototherapy with minute doses until the whole body could be exposed. The legs and arms were gently massaged, while the flexion deformity of the joints were daily stretched and passive motion given. He was able to walk with assistance on the fiftieth day, post-operative, and discharged without any symptoms on the seventy-ninth day, having gained fifty-six pounds since admission.

At the last examination, December 22, 1927, the chest was resonant throughout and the muscular system normal. He was able to walk three to five miles without fatigue and had returned to work in his office.

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## ACUTE SUBPECTORAL ABSCESS

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ACUTE inflammations beneath the pectoral muscles may be observed, as elsewhere in the body, under a variety of circumstances. Were it not for the fact that their anatomical location endows them with certain diagnostic difficulties and prognostic consequences of a serious nature, they would be entitled to no special consideration. However, occurring, so to speak, at the crossroads between the arm, the neck and the thoracic cavity, they acquire a significance much greater than the literature devoted to them would indicate. Since the presentation of two excellent articles by Crouzet<sup>1</sup> and Musser,<sup>2</sup> little beyond the report of isolated cases has appeared upon this subject. In the American literature of the past twenty years, relatively few instances of this type of abscess formation have been reported. It may be that the condition is of rather infrequent occurrence. Thus, in a series of 1080 consecutive cases of inflammatory disease occurring at the Eppendorfer Krankenhaus in Hamburg, Kümmel is reported to have seen only twenty-six involving the subpectoral region. On the other hand, it must be considered as unusually singular, not to say fortunate, that within the space of a few years, five cases, three of them observed personally, should have come to my attention. Two of these present an etiology not previously described and all together give so good a resumé of the clinical picture of subpectoral abscess that they may justify a discussion of this interesting subject.

The term "subpectoral abscess" has been used, in its broadest sense, to describe any collection of pus found topographically beneath the pectoral muscles. Thus Crouzet has included in his classification both *supracostal* inflammations, occurring between the ribs and the pectoral muscles, and *infracostal* inflammations, occurring between the ribs and the parietal pleura. The inflammations of this latter category, admittedly rare, have been described by several authors under the more specific name of peripleuritis, infection of the space existing between the parietal pleura and the endothoracic fascia. Though I have been accorded the opportunity of examining a case of calcification of a traumatic peripleural hæmatoma, I have never seen a case of localized peripleuritis. From the observations recorded by Crouzet, Vogel and others, it appears that peripleuritis clinically resembles circumscribed areas of pleuritis for which it may easily be mistaken, rather than true subpectoral abscess formation. Occasionally, a peripleuritic abscess has been described as breaking through the endothoracic fascia and thus secondarily leading to the infection of the subpectoral space. However, this accident must obviously be considered as among the greatest of rarities and it would, therefore, seem more accurate to exclude this lesion from the category of subpectoral abscesses.

Strictly speaking, this designation should be limited to those collections of pus which are found in an anatomically delimited space lying between the pectoral muscles and the ribs to which the name subpectoral may be properly applied. The bacterial infections of this space may be chronic, due to the tubercle bacillus or acute, due to the common pyogenic organisms. Of the acute type, two varieties, a mild, circumscribed and a fulminating diffuse, variety, have been observed and described by Tillaux.<sup>14</sup> While either the

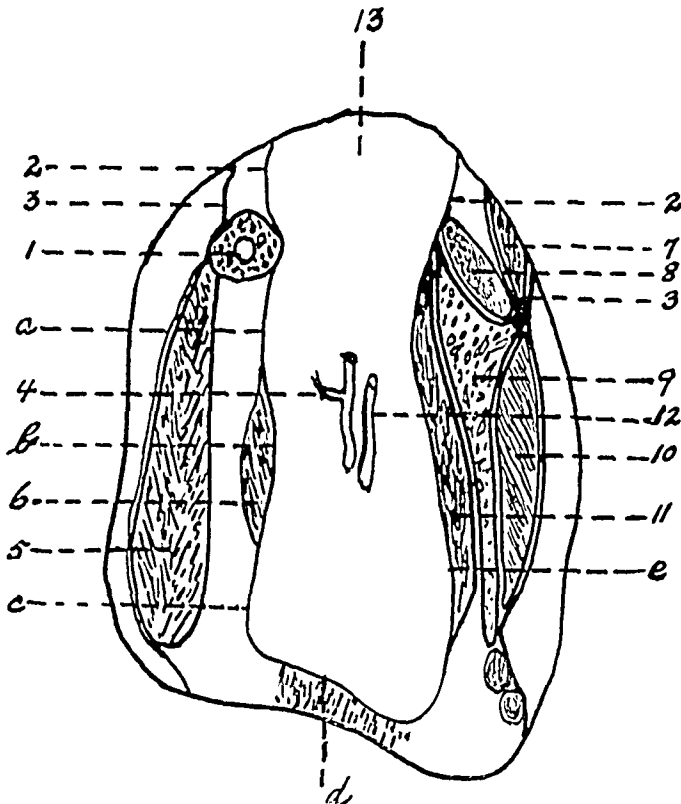


FIG. 1.—Sagittal section of the axilla, slightly internal to the coracoid process. (Moreau, loc. cit. p. 752). 1, Clavicle; 2, Middle cervical aponeurosis; 3, Superficial cervical aponeurosis; 4, Anterior thoracic vessels; 5, Pectoralis major; 6, Pectoralis minor; 7, Trapezius; 8, Supraspinatus; 9, Scapula; 10, Infraspinatus; 11, Subscapularis; 12, Axillary vein; 13, Cervico-axillary passage; a, Clavipectoral portion of fascia; b, Subpectoral portion of fascia; c, Infrapectoral fascia; d, Horizontal portion of fascia attached to skin; e, Subscapular fascia.

chronic or acute type of abscess might have been used as a paradigm, the latter has been chosen for the purpose of this communication because it brings into bolder outline the clinically different pictures determined by localization of the infection in anatomically differentiated parts of the larger subpectoral space.

In most text-books of anatomy, the subpectoral space as an entity has been accorded relatively little consideration. The major part of the author's attention has been focused upon a consideration of the axilla, which forms a part, indeed a large and important part, of the more extensive subpectoral space. Under the influence of Tillaux's interest in the

spread of subpectoral abscesses, Moreau<sup>7</sup> made a special study of the limits of this region on a number of fresh cadavers. His conclusions in brief, may be summarized in somewhat the following manner. The subclavicular, subpectoral space is continuous through the cervico-axillary passage with a space formed above the clavicle in the neck by the reflections of the middle cervical fascia. As this fascia descends from the neck, it becomes attached in front to the sternum, the clavicle and the scapula, while behind it is attached to the first rib along its entire arc. Below the clavicle, portions of this fascia are designated by special names: scapular, infrapectoral, clavi-pectoral or axillary depending upon their topographical locations. This fascial arrangement defines a roughly pyramidal-shaped infra-clavicular space which may be called



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the *deep* subpectoral space and which extends from the sternum in front, through the axilla to the subscapular region behind. (Fig. 1.) Anteriorly it is covered by the pectoralis minor muscle, and the costocoracoid membrane, postero-externally by the scapular muscles, and postero-internally by the serratus. Below, it is closed by the axillary fascia while above it is open to give passage to the large vessels and is continuous with the fascial spaces of the neck. In this deep space, lie the main lymphatic glands draining the arm and the chest wall, as well as the large venous trunks of the arm. Suppuration occurring in any of these structures, the sequence of suppuration anywhere within the region of their distribution, may lead directly to infection of the deep pectoral space. From a realization of the extent of this deep space, the pointing of a deep subpectoral abscess either into the neck, into the axilla or into subscapular region posteriorly will be readily comprehensible.

The presence of the *superficial* subpectoral space is determined by the fact that the pectoralis minor muscle is enveloped in a separate dense fascial layer, which above fuses with the costocoracoid membrane and below becomes continuous with the axillary fascia. This excludes the space beneath the pectoralis major from continuity with the previously defined deep subpectoral space and gives rise to a space which on sagittal section is roughly triangular in shape. Above, this space is closed by the clavicle, below, it is open, except for the covering of the skin. Anteriorly, it is bounded by the pectoralis major, posteriorly by the pectoralis minor and the costocoracoid membrane, internally by the sternum and externally by the humerus. In addition to a group of small vessels and nerves, this space contains several of the pectoral group of lymph-glands which lie on the deep fascia along the lower border of the pectoralis minor muscle. These drain the pectoral and subaxillary portions of the chest, the outer part of the mammary gland as well as occasionally the skin from the region of the abdomen. Suppuration in these glands resulting from infections in the area drained by them may lead to abscess of this superficial space. Such abscess may point either outward to the skin at the lower border of the axilla or by following along the course of the pectoralis major, may appear in the space between the deltoid and the pectoralis major muscle.

This definition of a deep, subpectoralis minor space and a superficial, subpectoralis major space is not only of interest to the anatomist, but is also of the utmost importance to the clinician, inasmuch as it affords the anatomical basis for an understanding of the two different varieties of subpectoral abscess: viz.: the diffuse subpectoralis minor and the circumscribed subpectoralis major types. These types differ from one another in their anatomical location, in their clinical picture and in their prognostic consequences, as the following case histories may best illustrate.

CASE I.—*Subpectoralis minor abscess.*<sup>14</sup> Male, aged twenty-nine, was admitted to the hospital, October 27, 1925, complaining of pain in the right shoulder region. He gave a history of having suffered from recurring osteomyelitis of various bones. At

the age of thirteen, he was treated for an osteomyelitis of the right os calcis. Six months later, he developed an osteomyelitis of the head of the right femur and a septic arthritis of the right hip. A month after this, large abscesses developed over each tibia which necessitated incision. No osteotomy was performed at this time, and the wounds healed slowly. For the next four years, the patient was apparently free of any acute osteomyelitic symptoms. Though constantly under observation and treatment, he was



FIG. 2.—Röntgenogram showing osteomyelitis of coracoid process. No evidence of pyarthrosis

able to do light work. Ten days before admission, the patient suddenly developed high fever and began to complain of pain in the region of the right shoulder. The slightest motion of the arm caused pain. His family physician applied cold wet dressings and a splint which apparently only served to increase the pain. A consultant, who saw the patient, made a diagnosis of pyarthrosis of the right shoulder and advised his removal to the hospital. On admission, the patient was obviously acutely ill. His temperature was 103.6° F., his pulse 120, and respiration 40. Except for the local condition, the physical findings were immaterial and of only historical interest. In the region of the right pectoral muscles, the skin was tense, hot, and of copper-colored hue. The whole anterior portion of the right chest was prominent, the swelling extending from the point of the shoulder well down to the nipple. The subclavicular space, well developed upon the left side, was completely obliterated on the right side. Attempts at abduction of the

right arm brought a sharp pain response from the patient. The axilla was apparently free and not bulging. Tension made on the edge of the pectoralis major muscle caused increase of pain. At about the level of the right coracoid process, a slight but definite pulsation was seen. There were distinct signs of fluctuation. X-ray photograph showed a low-grade osteomyelitis of the coracoid process as well as of the axillary border of the scapula. (Fig. 2.) There was no evidence of a pyarthrosis. The Wassermann test was negative. The white count showed 11,800 leucocytes of which 78 per cent. were polymorphonuclears. Blood culture taken on this day was subsequently reported negative. The pectoral region was aspirated and a syringe of thick pus from which *Staphylococcus aureus* was later cultured was withdrawn. A tentative diagnosis of

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subpectoral abscess due to osteomyelitis of the coracoid process was made and the abscess immediately widely opened and drained. The abscess cavity was found to extend downward to the lower level of the axilla and upward over the shoulder to the supraspinatus fossa. With the finger, the exposed roughened bone of the coracoid process could be easily felt. Following operation, the patient appeared to be somewhat improved, though the temperature still remained high, varying between 102° and 104° F. As the subsequent course of events demonstrated, the patient was already suffering from a generalized pyæmia which ultimately resulted in his death. On November 6, the patient complained of pain in the left chest. The physical signs of pulmonary consolidation were elicited and were confirmed by the röntgenogram. On November 11, a crop of small skin pustules suddenly appeared over the whole body. Culture of the contents of several of these showed the presence of *Staphylococcus pyogenes aureus*. There was a marked enlargement of the submental glands and several days later a breaking down which necessitated incision. Culture of the pus obtained from these glands also showed *Staphylococcus pyogenes aureus*. On November 12, a large abscess developed over the right deltoid region. Wide incision showed that this cavity was continuous with the subpectoral cavity previously opened. The patient now began to develop metastatic abscess requiring incision all over the body. All showed the same organism, *Staphylococcus aureus*. December 3, a large abscess continuous with the subpectoral abscess was discovered and opened in the posterior axillary line. X-ray photographs showed an extension of the osteomyelitic process in the scapula as well as in the head and upper third of the humerus. In spite of the usual methods of treatment, in spite of blood transfusion and the use of autogenous vaccines, the patient gradually went downhill. On December 21, he complained of pain in the right chest and dyspnœa. A bed-side X-ray showed a consolidation of the right lung with effusion into the right pleural cavity. Culture of this fluid showed *Streptococcus hæmolyticus*. Blood culture taken at this time also showed 15 colonies of *Streptococcus hæmolyticus* per cubic centimetre. It was felt that this was probably a terminal infection since all previous cultures had shown *Staphylococcus aureus*. On the 25th, the patient died. Autopsy was not permitted. The history was filed under the following headings: chronic recurring osteomyelitis, osteomyelitis of the right coracoid process, with secondary right subpectoral abscess. Complications, *Staphylococcus aureus* pyæmia, multiple metastatic abscesses, terminal hæmolytic streptococcus septicæmia, broncho-pneumonia and acute fibrinous pleurisy with effusion.

It might be maintained, of course, that the development of subpectoral abscess in this case was merely the expression of an already existing pyæmia, rather than a sequel to osteomyelitis of the coracoid process. However, in view of the history of a chronically recurring osteomyelitis of long standing, of the definite evidence of advanced involvement of the coracoid process and of the appearance of the subpectoral abscess, some time before the manifestation of signs of generalized pyæmia, it is felt that the osteomyelitis of the coracoid process was antecedent to rather than coincident with the subpectoral abscess. In such event, the development of abscesses in the supraspinatus fossa, in the subscapular region, along the arm and the later appearance of metastatic abscesses throughout the body would be completely comprehensible on the basis of an understanding of the anatomy of the deep subpectoral space and of the serious prognostic consequences of infection in this region.

In another case to which reference is made only in passing because of the lack of any of the details, death resulted in an almost similar manner from infection of a finger with secondary involvement of the subpectoral space.

CASE II.—This case, from the private records of Dr. Walter M. Brickner, also belongs to the category of the subpectoralis minor abscesses. While it depicts the seriousness of the condition by the severity of the symptoms, it at the same time shows the value of early recognition of the condition and the institution of an adequate surgical treatment.

Mrs. L., age forty-six, was first seen December 26, 1916. She gave a history of having cut her right index finger on the previous day. The following day she had chills, a fever as high as  $105^{\circ}$  F. and was obviously acutely and seriously ill. She complained of severe pain in the region of the right shoulder. Motion of the arm was painful. There was a fulness in the right subpectoral region and pain on pressure. A diagnosis of deep axillary subpectoral abscess was made. This was incised, a large amount of pus evacuated and drainage instituted. No record of the bacteriological findings in the pus was made. The fever soon began to drop and within several days the patient was discharged cured.

The clinical picture of subpectoralis minor abscesses thus far sketchily depicted in the above recorded cases may be contrasted with that seen in the type of subpectoralis major abscess of which Case III is an example.<sup>15</sup>

CASE III.—Sarah S., aged sixteen, was admitted to the hospital, July 10, 1924, complaining of pain in the right pectoral region. There was no history of trauma or recent infection on the hand or on the abdominal wall. The patient was well developed and apparently not acutely ill. Motion of the right shoulder was painful. The subclavicular depression was obliterated but the axillary space retained its normal contours. The temperature was  $100.6^{\circ}$  F. In the right pectoral region there was a uniform, bulging of the chest wall. The skin over this area was slightly reddened and was tender to the touch and gave a suggestion of fluctuation deeper in the tissues. Any attempt to put the pectoral space under increased tension, either by grasping the edge of the pectoralis major or by abducting the shoulder, caused increased pain. Slight passive antero-posterior motions of the shoulder could be performed painlessly. This apparently indicated the absence of any intra-articular lesion in the shoulder-joint. A diagnosis of subpectoral abscess was made and under general anæsthesia, a two-inch incision was made over the pectoral muscle. On bluntly separating the fibres of the pectoralis major a large amount of creamy yellowish pus was evacuated. The pus came from beneath the pectoralis major muscle, but pointed anteriorly, and not down into the axilla. There was no apparent communication with the ribs, the clavicle, the humerus, or the shoulder-joint. A wet dressing was applied without draining. Within two days, the patient's temperature had dropped to normal. On July 14, the patient was discharged cured.

In Case IV the sequence of events is not entirely clear and the case is presented somewhat hesitantly because both operative and bacteriological data are wanting.<sup>16</sup> Still it is of interest as indicating another possible origin for the development of subpectoral abscess which to the best of my knowledge has not previously been described.

CASE IV.—Male, aged twenty-one, came to the out-patient department complaining of pain in the region of the left shoulder. In January of 1925, he had been ill with pneumonia from which he apparently recovered without any complications. About one month after his recovery, he began to complain of pain in the left acromio-clavicular region. The pain though continuous, was not sufficient to interfere with his work. He noticed, however, that after especially strenuous work his shoulder became some-

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what stiff. About three months after the onset of the pain, he observed the appearance of a swelling in the left pectoral region which gradually increased in size. There was no history of chills or fever and venereal infection was denied. In the left pectoral region, extending from the clavicle down to the anterior axillary line there was a large, tense, fluctuating swelling, tender to the touch. The skin over it was warm and slightly œdematous, but not red. The subclavicular space was obliterated but the axilla was free. The axillary glands were somewhat enlarged. Abduction of the arm caused increased pain. It was felt that we were dealing with an abscess deep to the pectoral muscle and aspiration revealed the presence of a thick, creamy, yellowish pus beneath the pectoralis major muscle. On smear, there was numerous Gram-positive cocci, but culture of this pus remained sterile. The patient was referred to the hospital for



FIG. 3.—Röntgenogram showing probable abscess of the outer end of the clavicle.

operation. X-ray of the shoulder region showed "a gouged-out area at the acromial end of the clavicle which involves the medulla and cortex of this bone with the production of an extensive osteo-periostitis at the site of the lesion as well as in the entire shaft of the clavicle. There is an osteo-periostitis of the upper and outer aspect of the left humerus in the region of the cervical neck." (Fig. 3.) In an earlier X-ray this defect in the clavicle had been considered suggestive of a gumma. The blood Wassermann test, however, was negative. The blood contained 8700 white cells with 58 per cent. of polymorphonuclears per c.c. The temperature on admission was 98.8° F., respiration 20, pulse 72. Because of the patient's objection to operation and because of the apparent benignity of the infection, it was decided to treat the condition by repeated aspiration rather than by wide incision. Pus aspirated on several occasions showed neither the tubercle bacillus nor any other organism. Since this abscess was not widely opened and since no culture of the organism was ever obtained from this case, it was impossible to definitely establish the etiology or the mechanism of development of this abscess. However, because of the clinical appearance of the patient and the subsidence of symptoms after a period of only two weeks of treatment, it was believed that the patient had suffered from a subpectoral abscess secondary to an osteomyelitis of the outer end of the clavicle and he was discharged with that diagnosis.

In view of the inadequacy of the findings in this case, no too great weight must be given it. However, the development of pain in the region of the shoulder shortly after pneumonia, the appearance of an abscess in the subpectoral region and the demonstration of a definitely inflammatory loss of continuity in the outer end of the clavicle are interesting. Though these facts can by no means be considered as having any definitely established etiological relationship, they might be considered as suggesting a causal sequence of events, viz.: pneumonia, pneumococcic abscess of the clavicle with perforation and secondary infection of the subpectoralis major space. Both the attenuation of the bacteria and the localization of the infection might well account for the relatively innocuous clinical course.

Several different theories have been advanced in the explanation of the development of subpectoral abscesses. Musser<sup>8</sup> considered trauma as the most common cause while Ashhurst<sup>1</sup> looks upon the infection of a hæmatoma consequent upon a trauma as the most likely origin of these abscesses. On the other hand, Tillaux<sup>14</sup> is of the opinion that the majority of these abscesses are secondary to a lymphadenitis arising from some other focus of infection such as the finger. It has even been claimed by some that infections of the thumb and index finger are more apt to lead to subpectoral abscess formation because the lymphatic drainage from this area may reach the axillary nodes without interception in the epitrochlear glands. While the significance of an axillary lymphadenitis in the formation of these abscesses must be admitted, so definite a localization of the area of primary infection can by no means be accepted. Cases have been reported in which the focus was situated not on the thumb or index finger but elsewhere upon the hand, Pfeiffer,<sup>10</sup> Riesman,<sup>12</sup> Rodelius,<sup>13</sup> Davis,<sup>4</sup> etc. Some authors have called attention to the fact that infection about the waist-line or even in the lung may occasionally lead to the breaking down of the antero-lateral or infero-lateral group of thoracic lymph-glands and thus secondarily to the formation of a subpectoral abscess. Renaut<sup>11</sup> described a case following an infection about the elbow and terminating by perforation into the lung, while others have described the formation of these abscesses secondarily to infections in the neck or in the pharynx.

Though these may be the more important of the different manners in which subpectoral abscess develop, they by no means exhaust the list of etiological mechanisms. Cases have been reported as due to furuncles of the axilla, hypodermic injections, splinters, or osteomyelitis of ribs. Others have been occasioned by grippe, pharyngeal anginas, otitis media or puerperal sepsis. Without attempting any too elaborate classification, it may make for clarity to consider subpectoral abscess as due to:

(1) *Penetrating injuries* where the infecting organism is actually introduced beneath the skin by splinters, hypodermic injections, hypodermoclysis, bullet wounds, stab wounds, aspiration of empyemata, etc., Henschen.<sup>5</sup>

(2) *Traumatized* where as a result of a blow or of a sudden strain upon the pectoral muscles, a hæmatoma, i.e., a locus minoris resis-

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tentiae develops and becomes secondarily infected through the blood stream.

(3) *Lymphatic infection* where an infection upon the hand, the breast, or the abdomen, or a retro-grade lymphangitis from the mediastino-axillary glands may prove to be the point of origin.

(4) *Hæmatogenous infection* where a general systemic disease, such as grippe, puerperal sepsis, scarlet fever, typhoid fever, staphylo- or streptococæmia, etc., may lead to the formation of infected emboli.

(5) *Perforation of abscesses* in neighboring structures where, for example, furuncles of the axilla, typhoid abscess of the ribs, osteomyelitis of the clavicle or the coracoid process, purulent subacromial bursitis, pleural or pulmonary collections of pus, etc., Banks.<sup>2</sup>

The organisms most commonly found in cultures from subpectoral abscesses are, as might have been expected, the staphylococcus and the streptococcus. However, practically all of the other pyogenic bacteria have been reported. Among these are the gas bacillus, the pneumococcus, the typhoid bacillus, and a large number of the anaërobic bacteria. As compared with the strepto- and staphylococcus, these organisms are, however, of extreme rarity.

Clinically, subpectoral abscesses are of two varieties, the relatively benign subpectoralis major type and the relatively malignant subpectoralis minor type. The reason for this variation in the severity of their symptomatology was suggested earlier in the discussion of the anatomical configurations of the two spaces in which these abscesses develop. It was shown that the subminor space is of much greater dimensions than the submajor space and consequently offers a greater surface for absorption of toxins. It was shown further that because of their depth beneath the skin, there was relatively less a tendency for these later abscesses to point toward the skin and consequently a greater tendency for their spread along fascial planes into the neck, the back, along the arm and occasionally even through into the pleural cavity.

The subpectoralis major type is usually mild in onset. The patient complains of moderate pain in the pectoral region and motions of the arm cause a rather marked increase in the pain. There is a swelling in the pectoral region with obliteration of the subclavicular fossa. The skin over the swelling is red and cedematous. There is a slight rise in temperature and a moderate leucocytosis. But withal, the patient does not look desperately sick. If left to itself, the abscess usually tends to point toward the lower part of the anterior axillary fold.

The subpectoralis minor variety, on the other hand, is quite different. Its onset is usually sudden with chill, a sharp rise in temperature and a marked leucocytosis. The patient soon looks sick and septic. At first, but little may be seen locally and a mistaken diagnosis of rheumatism, pleurisy or sepsis is made. The patient complains of pain in the pectoral or shoulder region and motion of the arm is excruciatingly painful. Similarly, grasping

the edge of the pectoral muscle between the fingers causes an increase in tension and pain. As the abscess increases in size, the subclavicular fossa is obliterated but the axilla usually remains free. As the pectoral muscles are raised by the growth of the abscess, the skin becomes copper colored and cedematous. Because of the proximity of the axillary vessels, pulsation of this swelling is occasionally seen. The abscess may spread to the neck or the back or may even perforate into the pleura or the lung. General sepsis with the development of metastatic abscesses throughout the body is by no means unusual. In any case, the prognosis is grave, and if treatment is too long delayed may be fatal.

While in most instances, the diagnosis can be easily established, cases have been reported where even the most experienced have been led astray. In some, though the patient was obviously dying of sepsis, the diagnosis could not be definitely made until autopsy established the presence of a huge subpectoral abscess. As a consequence practically all who have written upon this subject have warned of the necessity of examining carefully for subpectoral abscess in all cases presenting the evidences of sepsis of undetermined origin. Frequently the physician's attention is focused upon the region of the shoulder by the appearance of pain on motion of the arm. The diagnoses of rheumatism, of purulent arthritis, of myositis, of subacromial bursitis, have been made, though they have been warranted neither by the clinical picture nor the röntgenologic findings. In such cases operations have often been deferred to the patient's detriment. In other cases where the appearance of a swelling has attracted the attention of the physician, early incision has been resorted to and tuberculous abscesses have been unnecessarily opened and subjected to the dangers of secondary infection by the pyogenic bacteria. Moreover, Ohlmann<sup>9</sup> has called attention to the fact that in children suffering from severe types of pneumonia, an œdema of the chest wall simulating the swelling seen in subpectoral abscesses may occur and lead to unnecessary surgery. Other diseases of childhood, such as umbilical sepsis, cardiac decompensations, etc., may also simulate these abscesses. However, pain in the region of the shoulder made worse by grasping the pectoral muscle or by abducting the arm, the presence of fever, the history of a cut, abrasion, or any antecedent acute pyogenic infection, should in the presence of a sepsis of undetermined origin immediately suggest careful examination of the pectoral region.

Once the diagnosis has been definitely established, the only therapeutic measure is incision and drainage. This is best undertaken along the lower border of the pectoralis major muscle. In the superficially situated subpectoralis major type, as in Case III, simple incision even without drainage may be sufficient to result in cure. In the subpectoralis minor type, counter-incisions, posteriorly or in the neck, may be necessary to secure adequate drainage. In all cases, the urgent indication is for incision and drainage. In the mild case, early incision leads to rapid cure, in the severe type to hesitate is to be lost.



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# PULMONARY EMBOLISM

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IN THINKING of pulmonary embolism we are all too prone to consider it as something which is very rare, yet in nearly every community of any size there can be found laymen who can tell of some friend, who following some operation was doing nicely and suddenly died. It is natural to believe that a part of these, which in the past were called apoplectic strokes or cardiac failure, were in reality the blocking off of the major portion of one lung by a large embolus, which had broken away from its moorings, at its point of formation, and occluded one or both of the pulmonary arteries, or the major portion of their branches.

Victor reports that at the New York Hospital from 1915 to 1924 in a series of 12,615 operations there were twenty-one cases of fatal pulmonary embolism. These occurring from sixteen hours to forty-seven days after operation, on an average of thirteen days. The average age of the patients being forty-three years.

Frischman reports one case of fatal pulmonary embolism in a woman fifty-five years of age with an epithelioma of the vulva, and treated only with radium and diathermy.

Rupp in performing 13,000 autopsies from 1903 to 1920 found a mortality rate of 1.1 per cent. from pulmonary embolism in internal disease, the average age of this series being fifty-two years. During the same period in 22,689 operations he found an incidence of .26 per cent.

Lindsay at the London Hospital reports ninety-six cases in a series of 31,426 operations from 1919 to 1924, an incidence of .3 per cent.

At the Peter Bent Brigham Hospital in Boston in 1920, Cutler and Hunt, in a series of 1604 operations, found sixty-three pulmonary complications of various kinds; of this number forty-three followed abdominal operations, thirty-two of these were lung infarcts as shown by X-ray and two were massive pulmonary embolism. Both cases of frank pulmonary embolism were fatal, while none of the cases of lung infarct were fatal.

In 1922, at the Johns Hopkins Hospital, Wharton and Pierson reported eleven cases of pulmonary embolism following 1600 gynæcological operations. An incidence of .68 per cent.

Heard, in reviewing the incidence of pulmonary embolism at the Mayo Clinic, in 125,164 operations from 1912 to 1920 found 104 cases of the massive type, an incidence of .08 per cent.

Wilson at the same clinic had previously reported 36 fatal cases in 57,000 operations, from 1899 to 1912, with a percentage of .063.

From personal experience in the Vanderbilt University Hospital, we add the following case reports:

CASE I.—J. R., a colored female adult, forty-eight years of age. She was admitted on the gynaecology service complaining of pain in lumbar spine during menstruation, and metrorrhagia for past nine months.

The physical examination was negative except for a large, hard nodular mass in pelvis which was fixed and not tender.

The operative procedure carried out was a supra-vaginal hysterectomy and a bilateral salpingo-oophorectomy. Spinal anaesthesia was used for the operation until it gave out and then ether was given. The uterus was twice its normal size and contained an intra-mural fibroid tumor the size of a guinea egg with a necrotic centre about the size of a quarter. Sections from which showed a leiomyosarcoma. On the left side of the uterus, and attached firmly to it and densely adhered in the cul-de-sac was an abscess a little larger than the uterus itself, involving both the tube and ovary, and made up of two cavities, one of which was ruptured in removal. The pus from the ruptured abscess had the odor of pus due to the colon bacillus.

On the second and third days post-operative the patient showed signs of peritonitis with abdominal distention, slight nausea and vomiting, temperature  $101^{\circ}$  F., and some increase in pulse and respiratory rates. All intake by mouth was stopped and fluids were given in other ways. On the fourth day after operation the patient was better and the symptoms of peritonitis were clearing up. On the fifth day she was decidedly better and was taking fluids by mouth with no nausea and wanted to eat. Then about noon she suddenly lost consciousness and the nurse was summoned by another patient in the room. In a few minutes she roused up enough to speak and then lapsed into unconsciousness again. Respirations were stertorous and sighing. She was pulseless and there were no audible heart sounds. She was given 1 c.c. of one to one thousand adrenalin chloride solution and two grains of caffeine by hypodermic, by the interne. The patient lived about twenty-five minutes from the time she first became unconscious.

*Autopsy Findings.*—The entire left lower extremity was swollen. There was some adherence between the coils of intestines, but the peritonitis seemed to be clearing up. There was a partial obstruction in the ileum, but no free fluid in the peritoneal cavity. There were no pleural adhesions, and no free fluid in the pleural cavities. There was a large fresh embolus filling completely the left pulmonary artery and extending down into the smaller branches. There were also large fresh emboli in the branches of the right pulmonary artery. Both lungs appeared bloodless and constricted as though the blood supply had been cut off completely. Just above the bifurcation of the left common iliac vein there was found a large friable thrombus. This thrombus extended down into the left internal iliac vein and into its various branches and even partially occluded the external iliac vein. The last 3 cm. of the left uterine vein was filled with a thrombus. The emboli in the pulmonary arteries had come from the thrombi in the left common iliac vein. The point of origin was probably in the left uterine vein.

CASE II.—H. W., a colored female adult, thirty-six years of age. She was admitted on the gynaecological service complaining of dysmenorrhœa and metrorrhagia for past six months. Her physical examination was negative except for a hard, nodular mass in the pelvis. The operative procedure carried out was a supra-vaginal hysterectomy and a prophylactic appendectomy. She was given a nitrous oxide and ether anaesthetic. Three days after operation she developed symptoms of intestinal obstruction and the incision was reopened. This time she was given a nitrous oxide anaesthetic. Loops of intestine were found matted together and adherent in the pelvis. These adhesions were broken up and the obstruction relieved. Six days later she complained of weakness, nausea, and had a rapid pulse. On the following day in addition to the above symptoms she complained of pain in the chest and there were venous pulsations in the neck. She developed air hunger, her blood-pressure was 90 mm. systolic and 60 mm. diastolic, respiratory rate

44 and pulse rate 100 with lungs clear. The veins in the neck and axilla were distended. Death occurred at 3.45 A.M. on the eighth day following the second operation and eleventh day following the first operation, and several hours after the onset of acute symptoms.

*Autopsy Findings.*—Many loops of intestine were bound together by fairly firm recent adhesions. There was dilatation in the lower part of the ileum, with the bowel collapsed below, showing probably a complete obstruction. There was found a gray rough embolus about 1 cm. in diameter and 4 or 5 cm. long riding the bifurcation and extending into each branch of the pulmonary artery. The embolus does not completely occlude either pulmonary artery and beyond the ends of the embolus can be seen more recent thrombi. The right common iliac vein was found to contain a gray, laminated thrombus which extended into the internal and external iliac veins, extending from the external iliac into the femoral vein where it terminated. A thrombus was also found in the uterine vein on this side, beginning at the point of ligation and extending out into the internal iliac, into the common iliac and thence in both directions. The pulmonary embolus evidently broke away from the thrombus in the common iliac vein. The left common iliac vein and its branches were free from thrombi.

CASE III.—A. K., a colored female adult, fifty-nine years of age. She was admitted on the gynecology service complaining of a swollen abdomen, continuous bloody vaginal discharge and shortness of breath. Her physical examination reveals marked dyspnoea with no other chest findings. An enormously distended abdomen with dulness on percussion over the lower portion and in both flanks. On palpation a hard nodular mass could be felt through the abdominal wall. There was a sanguino-purulent vaginal discharge.

Two days after admission a paracentesis was done and 3300 c.c. of bloody fluid was removed. Seven days later an exploratory laparotomy was done under local anæsthesia. Three thousand c.c. of bloody ascitic fluid was removed. Finding a large fibromyoma which was degenerating and which it was impossible to remove, a biopsy was taken from the tumor and the incision promptly closed.

About twelve hours later (after using a bed pan) she became suddenly ill, began moaning and frothing at the mouth and died five minutes later. Artificial respiration was attempted by the interne but of no avail.

*Autopsy Findings.*—The abdomen was tremendously distended, and contained about 800 c.c. of blood-tinged fluid. There was a pelvic tumor mass extending well into the abdomen, the surface of which was nodular, smooth, lobulated and partially covered with blood. The uterus, tubes, ovaries and bladder could not be differentiated, and the terminal portion of the ileum, the cæcum and ascending colon, the sigmoid and rectum and isolated loops of small intestine are all matted into the tumor mass. The pulmonary arteries contained large thrombi which had separated themselves into layers, so that the cells were at one end and the clear serum portion was at the other. This was explained by our pathologist as being a post-mortem clot and due to gravity, the heavier formed elements in the blood had settled to the bottom. No cause was found for sudden death.

CASE IV.—F. C., a colored female adult, forty years of age. She was admitted on the gynecology service complaining of frequency of urination and menorrhagia for past year. She was told by a doctor that she had a tumor two years ago.

Her physical examination was negative except for a large hard nodular mass in the lower abdomen.

The operative procedure carried out was a supra-vaginal hysterectomy, bilateral salpingectomy, and a prophylactic appendectomy. The operation was begun under spinal anæsthesia and finished with ether. The next day following operation the patient was complaining of a burning pain in the epigastrium. The second day after operation she was slightly nauseated. On the third day she was considerably nauseated and abdomen was slightly distended, but her temperature was normal. On the fourth day the symptoms were the same but were more pronounced and a gastric lavage was done because

## PULMONARY EMBOLISM

of vomiting. On the fifth day examination of her chest revealed no pathology, her blood pressure was 150 mm. systolic and 90 mm. diastolic. Another gastric lavage was done and quite a lot of highly colored material was removed. The abdomen was now quite distended. About 6 p.m. her nurse went to dinner and on returning found the patient in an extreme condition. When I was called I found the patient unconscious, her extremities were cold, she was pulseless, and I was unable to elicit any heart sounds. She had three or four sighing shallow respirations and died. I was unable to obtain an autopsy, but the patient very likely died of pulmonary embolism, as the clinical findings point in this direction.

CASE V.—Mrs. V. W., a white female adult, forty years of age. She was admitted on the obstetrical service complaining of vaginal bleeding for past four and a half months. Her physical examination was negative except for a pregnancy of five months and a marked secondary anaemia with a haemoglobin of only 30 per cent. and a red blood-cell count of 1,580,000. A diagnosis of placenta praevia of the lateral type was made.

The next day after admission the amniotic membranes were ruptured. This failing to induce labor the following morning (about twenty hours later), a Voorhees bag was inserted in the cervix. The cervix was quite fibrous from tears during previous deliveries and dilatation was very slow. About forty-five hours after introduction the bag was expelled together with a five months' foetus (which had been dead a short while) and all of the secundines. There was very little bleeding at this time. Following her delivery the patient refused to have a blood transfusion. The next day she was showing signs of puerperal sepsis, but still refused a transfusion. On the second day post-partum she was given 300 c.c. of whole blood, which raised her haemoglobin to 55 per cent. On the tenth day post-partum she was given a second transfusion of 500 c.c. of whole blood. On the seventeenth day post-partum she was given 400 c.c. of citrated blood. During the puerperium two positive blood cultures were obtained. The offending organism being an anaerobic non-haemolytic Gram-positive streptococcus. Patient had nausea, vomiting and abdominal distention for two days before death, and both lower extremities had been swollen for a period of three or four days.

*Autopsy Findings.*—Both lower extremities swollen. The peritoneal cavity was filled with a cloudy amber-colored fluid containing a number of fibrin flakes and some of the loops of intestine were held together by fibrin. Both lungs show small reddish patches scattered throughout lower lobes. This was a broncho-pneumonia which appeared to be embolic. The uterus showed quite a degree of sub-involution. The endometrium was ulcerated and necrotic. Both tubes were acutely inflamed. The uterine and ovarian veins were thrombosed and filled with a purulent exudate and there were large thrombi in both external iliac veins.

The cause of death in this case was septicæmia, generalized peritonitis and pneumonia. However, the iliac veins being thrombosed to the extent of causing a considerable degree of œdema in the lower extremities. It was only a matter of time until emboli would have been dislodged and sent on an excursion of death into the lungs.

CASE VI.—E. J., a white female adult, twenty-two years of age. This case was admitted on the surgical service complaining of pain and swelling of left thigh and inguinal region for past three days.

The physical examination was negative except for a large area of swelling below Poupart's ligament on the left and extending toward the medial surface of the thigh. This area was slightly indurated and extremely painful and tender. Three days after admission she was given a nitrous oxide anæsthetic and this area on the left thigh incised. Two days post-operative she was given mercurochrome intravenously, followed by a transfusion of whole blood. On the fifth day after operation she became comatose and died. Our pathologist gave as the cause of death a streptococcus cellulitis of the left thigh. She also had thrombi in the left external iliac vein which completely obliterated its lumen, and infarction of the right lung plugging the descending branch of the right pulmonary artery and completely occluding its lumen.

CASE VII.—C. R., a colored male adult, fifty-five years of age. This case was admitted on the medical service. The chief diagnoses were hypertension, cardiac insufficiency, and auricular fibrillation. He was under treatment for four weeks before death. His blood-pressure on admission was 160 mm. systolic and 88 mm. diastolic. For a few days before death his blood-pressure was 70 mm. systolic and 45 mm. diastolic. There was a considerable degree of generalized œdema, his respirations were shallow, but no râles in lungs.

*Autopsy Findings.*—His chief cause of death was given as mural thrombi in the right ventricle. There was also found an embolus in the lower branch of the left pulmonary artery. The infarct was in the upper portion of the lower left lobe. The lung tissue surrounding the infarcted area was markedly congested. The infarct was about 2 cm. in diameter and contained a small abscess showing that the embolus was infected as the abscess was inside the infarct. There were no emboli in the branches of the right pulmonary artery.

CASE VIII.—J. W. B., a white male adult, sixty-eight years of age, was admitted on the medical service and a clinical diagnosis of chronic myocarditis, cardiac insufficiency and partial heart block was made. The patient was under treatment for nearly three months before death.

*Autopsy findings* were multiple mural thrombi in the left ventricle and right auricular appendage with necrosis of myocardium of left ventricle. In the lower portion of the upper lobe of the right lung was a large firm area, which was dark red in color and greatly congested. On section the infarcted vessels were readily demonstrated. The apex of this lobe was soft and crepitant. There were no areas of infarction in the left lung.

*Etiologic Factors.*—The average time for pulmonary embolism to occur, as given by various writers, following an operation is ten days. It may occur in a few hours and even after a period of weeks. The patients in this series who died of pulmonary embolism ranging from four to eleven days. It usually occurs at some such time after the patient has become a little more active and by exertion has dislodged the thrombus which becomes the offending agent.

In this series of cases of pulmonary embolism of both small and massive types the average age is forty-six years. That the great majority occur in patients who are past middle life there can be no doubt. Closely associated with the age of the patient is the condition of the patient, and the slowing of the blood stream or venous stasis. Here, too, may be considered the kind and length of anæsthetic, but Cutler and Hunt in their series have found pulmonary embolism just as frequently following a local anæsthetic as when the anæsthetic was general. Likewise Mann, at the Mayo Clinic, in experimenting with dogs found no difference in the rate of incidence when he injected artificially formed emboli into the blood stream of dogs who were healthy, diseased or when weakened by a prolonged ether anæsthetic. That any patient is weakened and has a certain amount of depression of the circulatory system by a general anæsthetic there can be no doubt, but when they occur just as frequently following a local or spinal anæsthetic, it makes us think that the form of anæsthesia is only a very minor part among the etiologic factors. That the lowering of the blood-pressure may be a contributory factor has been suggested and is borne out by one of the cases here reported, but on the other hand another of the more outstanding cases in this series

had a blood-pressure of 150 mm. systolic and 90 mm. diastolic only two hours before death. Here again we cannot be sure of this point because this same patient's blood-pressure may have been lower previous to this time, and had been stimulated only to break loose a thrombus and send it on an errand of death. As we consider the state of the blood as an etiologic factor, we come to the question of fluid content. That a patient who has been operated and who is suffering from nausea, vomiting, distention and the various symptoms referable to the abdomen will become dehydrated we all know. That one of the first tissues to suffer from dehydration is the blood we are reasonably sure. The consideration of the body fluids brings us next to acidosis as the principle contributors to acidosis, are lack of fluid intake and carbohydrate starvation. Then we see that acidosis while perhaps a contributing factor is entirely secondary to other causes.

Chilling and cold have been suggested as one of the etiologic factors, but in a well-conducted clinic it of course should at least be only a negligible quantity.

After having two parturients to die on the same day from pulmonary embolism, De Snoo suggests that they were due to bacteria of a special thrombosis inducing type. He also cites that of twelve fatal cases out of 10,000 deliveries eleven came from the pelvic veins and all of those developing pulmonary embolus had been delivered artificially. W. J. Mayo states that minute septic emboli from the operative field are a common cause of secondary pulmonary complications. Case seven in this series further bears out the fact that infarcts are due to septic emboli and may give rise to lung abscesses or broncho-pneumonia. On the other hand, when we look at the great number of cases of pulmonary embolism following some operative procedure, especially in gynæcological operations, in which there cannot be demonstrated any infection, again we feel that this too is not the principle cause.

In operating case one in this series to free an abscess of this size, quite a lot of trauma can easily be caused if we once forget to take care, when the abscess was freed there remained quite a large area of bleeding surface. To control this sponges were applied with some pressure. This further bears out both the idea of sepsis and that of trauma as there was septic material turned loose and considerable trauma done.

Rupp in his series of autopsies found the original site of the thrombus to be in the pelvic veins in 42 per cent. of the cases. Hampton and Wharton go still further and report an incidence of the offending thrombus arising in the pelvic veins in 85 per cent. of their cases. That this should be true there must be some definite reason. We know that of all operative procedures gynæcological operations head the list. Thrombi are more frequently formed in the left common iliac vein or one of its branches, which seems to be contributed to by the fact that it passes under the left common iliac artery. Therefore it seems that anatomical faults associated with septic material and undue operative trauma are the principle factors in leading to thrombosis in

the pelvic veins. Two of the most striking cases in this series were being kept on back rests with knees elevated as a prophylactic for the prevention of pneumonia, with the pelvis as the most dependent part of the body. That this should lead to venous stasis in the veins of this area, in a patient whose circulation is already at a low ebb is only reasonable to believe. Added to this may be considered abdominal distention with its associated increase in intra-abdominal pressure with consequent slowing up of the venous return as was present in four of the cases here reported.

*Symptomatology.*—Lung infarcts of the small type may go unnoticed. When they give rise to symptoms there is a sudden localized pain, especially if the infarcted area reaches the pleura, and in this case there will be a definite area of consolidation of lung tissue with an associated pleural friction rub. There may or may not be a chill. The sputum if any will be frothy and may be blood tinged. There will be a moderate elevation of temperature with a moderate leucocytosis. If the embolus was not infective the condition will clear in a few days, but if it carries infective material it may lead to pneumonia, gangrene or a lung abscess. When embolism of the massive type occurs it gives rise to such pronounced symptoms, that when this picture is once seen it can never be forgotten. To have a case feeling fine and apparently doing as well and find her in a state of shock, unconscious, dyspnoëic, cyanotic, low blood-pressure, weak pulse or even pulseless, frothing at the mouth and perhaps a degree of hæmoptysis is quite an appalling sight.

*Treatment.*—The best treatment for pulmonary embolism is prevention. If it can be demonstrated that a patient has an embolus at some point in the peripheral circulation, it may be successfully removed, and in cases of thrombophlebitis an intravenous injection of mercurochrome may be given. Although mercurochrome is overestimated, I believe it is definitely beneficial in thrombophlebitis, and I have had very good results in its use in these cases.

Trendelenburg has successfully operated upon pulmonary embolism in animals, but as yet there is no authentic case of successful removal in the human.

In two of our cases the interne administered cardiac stimulants. Nothing could be more harmful. After the major portion of the pulmonary arteries or their branches have been occluded, any stimulation of heart action with its concomitant increase in blood-pressure would only drive the emboli into the vessels tighter and would probably lead to dilatation of the right heart. So we see that once the condition has arisen there is no satisfactory treatment.

#### CONCLUSIONS

1. Pulmonary embolism occurs usually in patients who are past middle life.
2. It occurs just as often in internal disease as following an operation.
3. It is more frequent following gynæcological operations than any other procedure.



## PULMONARY EMBOLISM

4. Lung infarcts are never fatal unless septic, whereas emboli of the massive type are always fatal.

5. The principle etiologic factors in the production of thrombi are operative trauma, septic material, low blood-pressure with venous stasis, dehydration, anatomical arrangement of pelvic veins and an inforced recumbent posture for several days with perhaps some abdominal distention and its associated increase in pressure with consequent slowing up of the venous return.

6. It occurs just as often with local or spinal anæsthesia as when ether or gas is used.

7. The massive type is inevitably fatal, while the smaller ones are never fatal.

8. The principal symptoms of lung infarcts are localized pain, frothy sputum with at times a tinge of blood, moderate temperature and leucocytosis and a pleural friction rub.

9. The symptoms of the massive type are shock, dyspnoea, cyanosis, low blood-pressure and weak pulse, and unconsciousness.

10. The best treatment is prevention.

# HARELIP AND CLEFT-PALATE\*

A STUDY OF FOUR HUNDRED AND TWENTY-FIVE CONSECUTIVE CASES

By WARREN B. DAVIS, M.D.

OF PHILADELPHIA, PA.

THE four hundred and twenty-five cases in this series include the various types of harelip and cleft-palate deformities which have been under my care

from January 1, 1914, to November 1, 1927. I am indebted to Dr. J. Chalmers DaCosta for the opportunity of caring for all harelip and cleft-palate cases admitted to "Surgical Division A" at the Jefferson Hospital since 1915, which cases constitute nearly one-half of this series. The other cases were those on my service at the Philadelphia General Hospital from 1915 to 1920, those at the Frankford Hospital since 1922 (for which I thank Dr. Charles F. Nassau), and my private cases.

Fifty-six per cent. of the cases were males and forty-four per cent. females. The age of the patients at the time of first examination varied from one day to seventy-six years. Sixty-three per cent. of the cases were under seven months old. The types of the deformities, the number and the percentage of each type are shown in Table I.

Etiologic considerations show that heredity is a dominant factor, positive family histories being obtained in fifty-seven per cent. of our cases. The percentage doubtless would have been considerably greater if the knowledge of the family histories had been more extensive and accurate. In many cases our information was limited to only one or two generations. By positive history we mean not only the occurrence of actual clefts of lip or palate of some degree in some other member or members of the family within three generations, but also the congenital absence of one or both of the permanent superior lateral incisor teeth in some of the relatives. In

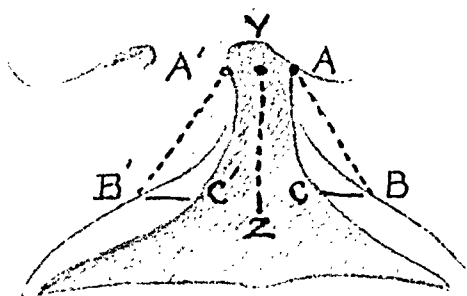


FIG. 1.—Semidiagrammatic sketch, showing lines of incisions used for the correction of unilateral harelip after the method of J. E. Thompson. Sharp pointed calipers are used in measuring the distance YZ from the midpoint of the floor of the nostril being constructed to the point in the same sagittal plane to which the free margin of the lip would come if it were of normal contour. Fixing the distance on the calipers and keeping the superior point at Y, the inferior point of the calipers is rotated describing an arc which crosses the vermilion border of the lip on either side of the cleft. These points B and B' are distinctly marked by making a puncture with the point of the calipers or with a small scalpel. Points C and C' are then located on the free margin of the lips so that the angles ABC and A'B'C are between 70 and 80 degrees. Incisions carried through the entire thickness of the lip with a small scalpel at a right angle to the skin surface and following the lines as outlined will give surfaces for approximation which are of equal length and which, when sutured together, will give a lip the length of which is the estimated normal length YZ plus the distance from the vermilion border to the free edge of the lip CB which is usually just sufficient to allow for subsequent contraction.

\* Read before the Philadelphia Academy of Surgery, December 5, 1927.

## HARELIP AND CLEFT-PALATE

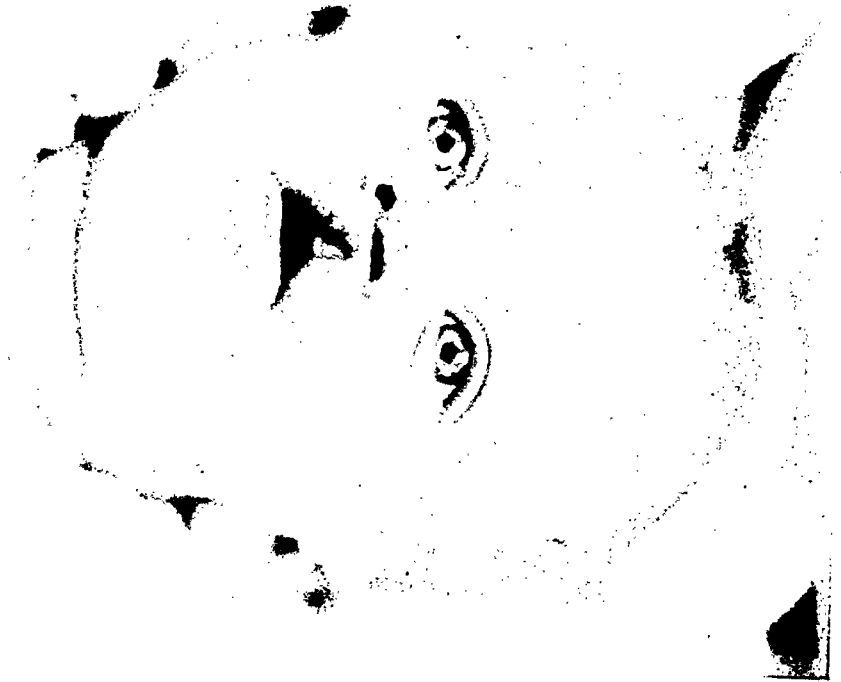


FIG. 2.—Case I. B. W., child, age seven months, with incomplete unilateral harelip. Note the absence of muscle tissue between the superior angle of cleft and floor of the nostril, deviation of the nasal septum, and flattening of the ala.



FIG. 3.—Case I. B. W., ten months after operation, showing contour of lip and nostril. The incisions used in this case were those of the Thompson method, carrying the incisions up into the floor of the nostril, removing sufficient tissue to allow the proper approximation of the ala to the septum after freeing the lateral portion of the lip and the antero-inferior portion of the cheek from the maxilla.

eighteen cases we have found this relationship existing between absent lateral incisor teeth in one generation and the presence of harelip or cleft-palate, or both, in a succeeding generation. In four instances the absence of the lateral incisor teeth occurred in a parent, in five instances in an uncle or aunt, and in nine instances in first or second cousins of the patient. We have been greatly interested in this tendency which we believe has not been previously pointed out. In the cases with a negative history for actual clefts we are now requesting the parents to coöperate in searching for relatives showing congenital absence of the lateral incisor teeth. We have not been able to prove syphilis an etiologic factor in any case. Race has some bearing—only one of our cases being a negro. Only six per cent. of the cases were Hebrews.

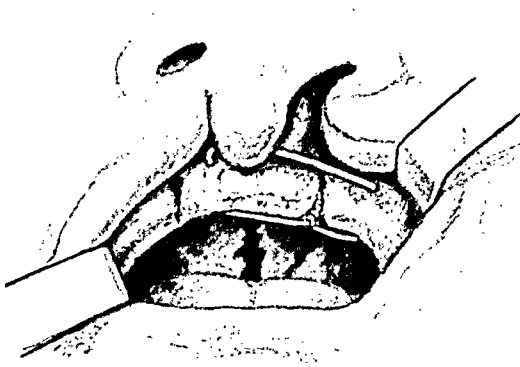


FIG. 4.—Semidiagrammatic sketch showing partial division of alveolar process posterior to the canine area on the right side to facilitate bringing premaxilla into normal position. A wire suture is used to hold the parts in apposition.

Other congenital defects which we found associated with harelip and cleft-palate deformities were supernumerary digits in four cases; deficiency in number of digits, one case; webbed fingers, one case; club-foot, one case; spina bifida, one case; hernia, eight cases; deficient development of mandible associated with microglossia, two cases; mongolian idiocy, one case; idiocy, three cases; distinctly defective mentality of less degree than idiocy, five cases.

The great value of the splendid coöperation which we have had from the Pædiatric Department at Jefferson, and also at the Frankford Hospital, is fully appreciated. Many of the infants were sent to the hospital in a very

TABLE I.

Unilateral harelip (left) .....	34 cases or 8%
Unilateral harelip (right) .....	21 cases or 4.94 + %
Bilateral harelip .....	13 cases or 3.05 + %
Median harelip .....	2 cases or 0.47 + %
Unilateral harelip and cleft-palate (left) .....	132 cases or 31.05 + %
Unilateral harelip and cleft-palate (right) .....	26 cases or 6.11 + %
Unilateral harelip and bilateral cleft-palate .....	8 cases or 1.88 + %
Bilateral harelip and unilateral cleft-palate .....	6 cases or 1.41 + %
Bilateral harelip and bilateral cleft-palate .....	55 cases or 12.94 + %
Unilateral cleft-palate extending into hard palate, without lip deformity .....	9 cases or 2.11 + %
Bilateral cleft-palate extending into hard palate, without lip deformity .....	85 cases or 20%
Cleft involving soft palate only .....	34 cases or 8%



FIG. 5.—Case II. R. M., age seventeen months, showing complete unilateral harelip and cleft-palate. Note rotation of premaxilla and flattening of the nostril.



FIG. 6.—Case II. R. M., showing contour of lip and nostril six months after operation. Alveolar process was partially divided lateral to the left canine area to allow the premaxilla to be forced into a proximately normal position, as shown in Fig. 4. This procedure also corrected the marked deviation of the nasal septum. Incisions for the lip were outlined by the Thompson method.



FIG. 8—Case III. E. C., showing contour of the lip and nostril, eight months after operation. Fourteen months after the first operation a second operation was done to correct the deformity of the right nostril. This was done by detaching the ala laterally and along the midportion of the right nasal bone allowing the ala to swing into normal position as a pedicled flap where it was sutured with an inner and outer row of interrupted black silk sutures. The area over the nasal bone from which the superior portion of the flap was removed was allowed to heal by granulation. Vaseline dressings were used. The area healed so rapidly that skin grafting was not deemed necessary.



FIG. 7—Case III. E. C., age ten weeks, showing an unusual, wide and extensive unilateral cleft of lip and palate in which the bony cleft extended into the floor of the orbit. The alveolar process was approximated and the lip reconstructed at the first operation.

# HARELIP AND CLEFT-PALATE

FIG. 9.—Case III. E. C., appearance of lip and nostril five months after second operation.



FIG. 10.—Case IV. M. M., age two months, eight days, showing complete unilateral cleft of lip and palate left side, incomplete harelip right side. Alveolar process was partially divided internal to the right canine area allowing premaxilla to be forced into normal position where it was held with silver wire. The left side of the lip was repaired at the same operation.





FIG. 16.—Case V. C. G., showing the appearance of lip and nostril five months after operation. The cleft in the palate was closed at this time. Eight months later the excess fullness of the lip lateral to the philtrum was corrected by removing a small amount of tissue from the postero-inferior surface of the lip on each side.

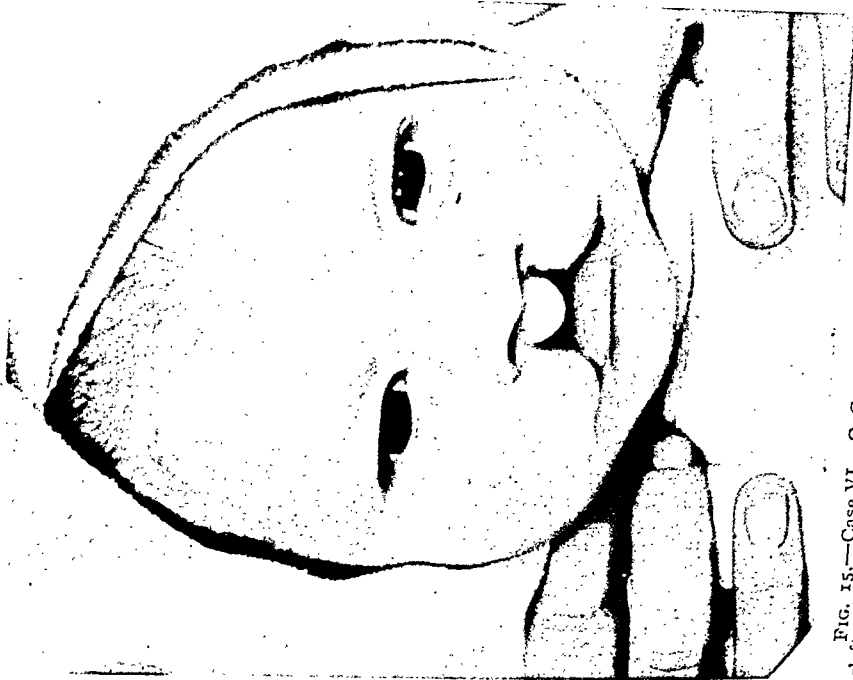


FIG. 15.—Case VI. C. G., age four months, bilateral harelip and cleft-palat. Displacement of the premaxilla was not marked in this case. Nearly the entire philtrum was utilized in the repair of the lip. The incisions were outlined as in Fig. 20.



poor state of nutrition and required much pædiatric care before their general condition would permit operative measures.

In nine cases of bilateral cleft-palate the development of the horizontal processes of the palate was so very rudimentary that operative measures were deemed inadvisable. In such cases dental plates supported by some of the teeth are used. Eleven cases included in this series are not yet in condition for operation. Twelve infants, who were never operated upon, died from nutritional disorders or respiratory infections.

Thus three hundred and ninety-three cases have been operated upon, the number of operations required on each varying from one to four, according to the type of the deformity. The surgical mortality was as follows: One case died on the operating table shortly after the administration of ether was begun and before any incision was made. Post-mortem examination showed an enlarged thymus and general lymphatism. Three died within twenty-four hours after operation from shock and pulmonary oedema. Four died after the twenty-



FIG. 17.—Case VI. C. G., showing appearance of lip and nostril fourteen months after the first operation on the lip and one month after second operation.

four-hour period and within six weeks, from pneumonia. A total of eight deaths or a two per cent. surgical mortality. One infant who died three weeks after operation from impetigo contagiosa bullosa (contracted in the ward one week after operation) is not included as a surgical mortality.

Careful observation of the ultimate conditions following the different types of operations shows that the best functional and cosmetic results were those obtained by the operative procedures, briefly outlined below, and described in the legends accompanying the illustrations.

Harelip deformities should be corrected as soon as the child is in condition to stand the operation—which is usually sometime between the tenth day and the third month. Incisions are outlined by the Thompson method. (Fig. 1.)

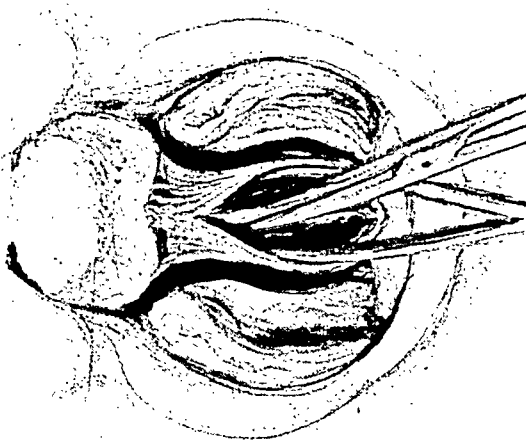


FIG. 18.—Sketch showing method of removing a section from the lower portion of the vomer and the anterior portion of the nasal cartilage. The removal of a triangular section of bone and cartilage allows infero-posterior rotation of the premaxilla to approximate its normal position. The length of the base of the triangular piece of bone and cartilage removed is determined by the amount of rotation which the premaxilla requires, and should be such that when the triangle comes into proper position the sides of the triangle will be brought together. There will be bulging of the mucoperiosteum at this point for several days, but the excess tissue soon resorbs.

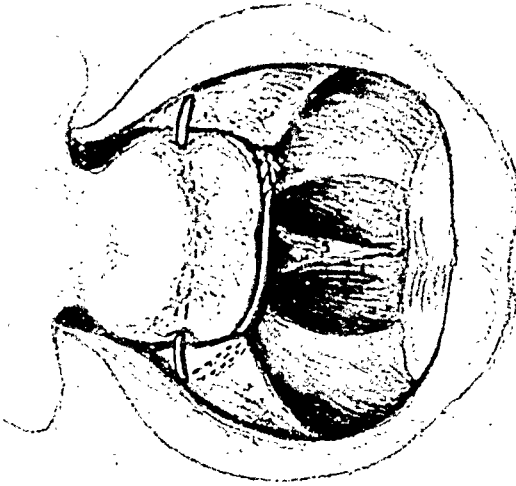


FIG. 19.—Lateral margins of the premaxilla and the margins of the alveolar process have had the mucosa removed from the points which will come in contact to allow approximation of the raw surfaces and permit fibrous union. The premaxilla is held into position by a wire suture which passes through the superior portion of the alveolar process on each side. It is carried in front of the premaxilla but posterior to the philtrum.

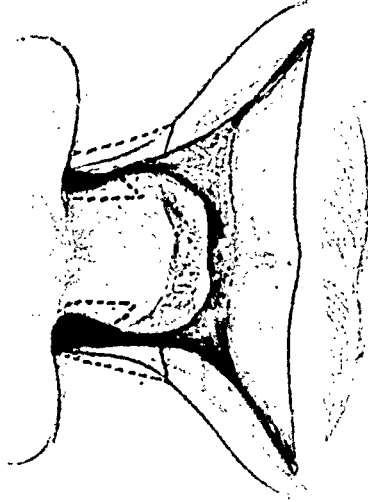


FIG. 20.—Sketch showing the approximate outlines for incisions which allow preservation of almost the entire philtrum in the closure of bilateral harelip. Incisions along these lines are carried through the entire thickness of the lip and the philtrum. The alae are brought into proper relation to the septum after which the points of the free edges of the philtrum and the corresponding points on the lip are brought into accurate apposition using care that the vermilion borders of the lateral portions of the lip and those of the philtrum are even. The lips shown in Figures 10, 13 and 15 were repaired by this method.

# HARELIP AND CLEFT-PALATE



FIG. 21.—Case VII. B. D., age two months. Approximate three-quarter view from the right side showing a very unusual bilateral cleft of the face. The bilateral cleft involved the lip and the alveolar process, but the palate posterior to the premaxilla was united. The clefts in the lip do not extend into the nostrils as in an ordinary case but pass lateralward extending into the orbits. These clefts into the orbits involve the bony structures as well as the soft tissues. Note the extensive coloboma. The naso-lacrimal ducts do not communicate with the inferior nasal meatus but pass posterior to the premaxilla and open into the roof of the mouth. Examination of the eye grounds by Doctor Shannon showed the fundus of each eye apparently normal.



FIG. 22.—Case VII. B. D., Three-quarter view from the left side. Note that the opening of the anterior nares is approximately on the same level as the pupils of the eyes. The anterior nares, although small, were well formed. The posterior nares were also well formed, but midway between the anterior and the posterior nares there was complete obstruction on both sides formed by a transverse partition of soft tissue covered by mucous membrane.



FIG. 23.—Case VII. B. D.; one month after the first operation, at which time the premaxilla had been forced into as near the normal position as possible the cheeks freed from the anterior surfaces of the maxillae, and brought medially and superiorly to form a floor for the orbit and to bring the lower eyelid medialward. Two operations were done after the stage shown in the above illustration for the further repair of the lip and the eyelids. A fourth operation was done to make an opening through the partition between the anterior and the posterior nares.



FIG. 24.—Case VII. B. D., showing condition of face three months after the first operation. Four operations were performed. The patient is to return in twelve months for further minor corrections.

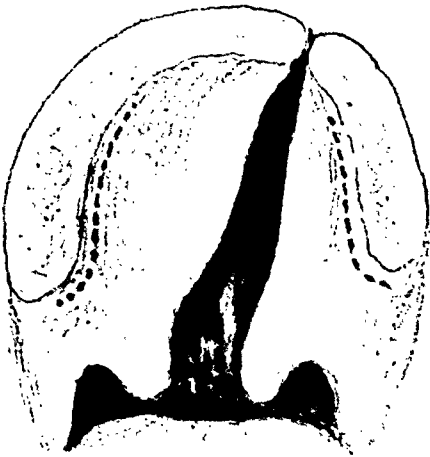


FIG. 25.—Semidiagrammatic sketch showing unilateral cleft-palate and the outline of incisions (slight extension of the Langenbeck incision) used in loosening the mucoperiosteal flap on the side attached to the vomer and loosening the flap containing the rudimentary horizontal process of the maxilla and of palate bone on the opposite side. The latter incision is carried through the periosteum after which the horizontal processes are cut through with a very thin chisel.

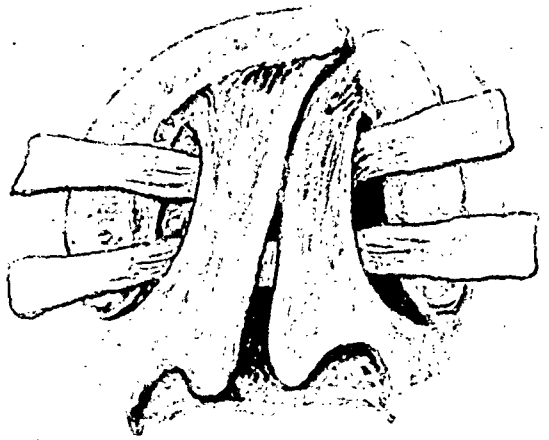


FIG. 26.—Semidiagrammatic sketch showing mucoperiosteal flap loosened on the patient's right side and a flap containing bone on the patient's left side. In the two-stage operation tapes are passed around both flaps and tied so as to hold the medial margins of the flaps in apposition, or nearly so, care being taken not to exert sufficient pressure by the tapes to shut off circulation. Iodoform gauze packs are used in the lateral incisions for twenty-four hours.

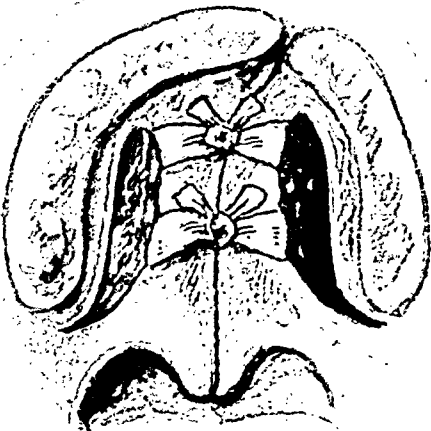


FIG. 27.—Semidiagrammatic sketch showing the tapes tied so as to hold the medial margins of the flaps in apposition. Iodoform gauze packs are used in the lateral incisions for twenty-four hours. One tape is removed on the third or fourth day, the remaining tape on the fifth or sixth day. On the seventh day the mucous membrane is removed from the margins of the clefts and sutures applied.

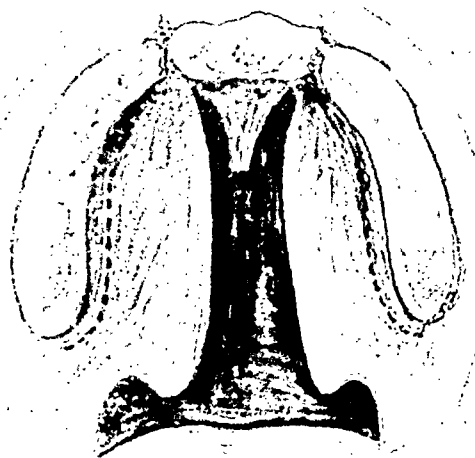


FIG. 28.—Semidiagrammatic sketch of bilateral cleft-palate, six or eight months after premaxilla has been placed in position and harelip repaired. Illustration shows the location of incisions which are carried down through periosteum, after which a thin narrow chisel is used to cut through the horizontal processes of the maxillæ and palate bones. Incision is then carried entirely through the mucous membrane forming the floor of the nostril, and the entire horizontal portion of the palate brought medialward.

Incomplete harelips must be made into complete ones by carrying the incisions into the floor of the nostril in order to get correct approximation of muscle tissue in the lip and to bring the ala of the nostril into proper relation to the septum. (Figs. 2 and 3.)

In unilateral harelip and cleft-palate the alveolar process should be brought together and the lip and nostril repaired preferably between the

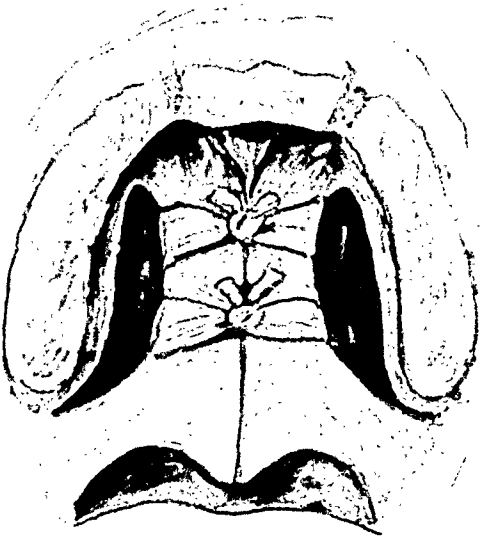


FIG. 29.—Semidiagrammatic sketch showing the method of loosening the flaps and bringing over bone in the repair of the double cleft-palate. The flaps are surrounded with two pieces of tape which are carefully tied so as to avoid cutting off any circulation. Iodoform gauze packing is used in the lateral spaces for twenty-four hours, both for the purpose of controlling any oozing and also to help hold the flaps in the desired position. One tape is removed on the third or fourth day, the remaining tape on the fifth or sixth day. On the seventh day the mucous membrane is removed from the margins of the clefts and sutures applied.

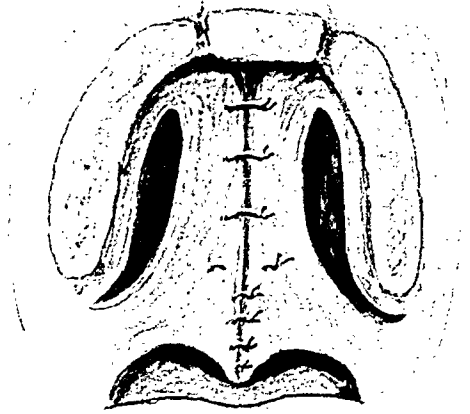


FIG. 30.—Semidiagrammatic sketch showing the application of sutures in a double cleft-palate in a two-stage operation. Double-ought wire sutures are used anteriorly, the sutures being carried through the entire thickness of the lateral flaps including the bone. These wire sutures are placed through the flaps before the mucous membrane is removed from the medial margins. This is important in that one is much less liable to detach the small strip of bone from its mucoperiosteal covering. One on-end mattress suture is used near the junction of the hard and soft palate. Posterior sutures are black silk. Tapes are again placed around the flaps as shown in figure 29, using care in seeing that they do not produce much pressure on the flaps. One tape is removed usually on the second or third day, the remaining tape on the fifth or sixth day. Remove only one or two sutures each day beginning about the ninth day and having all sutures removed on the fifteenth day after operation.

second week and the fourth month. This part of the repair can usually be done at one operation, leaving the cleft posterior to the alveolar process to be repaired later. In very young infants in which the alveolar cleft is not wide the premaxilla may be simply forced into nearly normal position by digital pressure. In older cases and in wider clefts with rotation of the premaxilla, closure of the alveolar cleft is facilitated by partially dividing the outer portion of the alveolar process lateral to the canine area with a thin chisel, allowing a greenstick fracture of the inner portion of the process when the premaxilla is forced into position. A wire suture through the alveolar process holds the margins in apposition. (Fig. 4.) The lip is then repaired as in simple harelip. (Figs. 5 to 9.)

In bilateral harelip the philtrum should be preserved, bringing its inferior edge down to form the centre of the lip margin. (Figs. 12, 14, 18, 20, 24.)

# HARELIP AND CLEFT-PALATE



Fig. 31.—Case VIII. Age twenty-eight years. Unilateral harelip, bilateral cleft-palate. Lip had been operated upon when patient was two years old and again when sixteen years old. Note that vermilion border was not properly removed from margins of cleft in lip, persisting as a disfiguring red line extending to floor of nostril.



Fig. 32.—Case VIII. Showing deviation of the nasal septum, flattening of ala nasi and contour of nostril. Wide bilateral cleft of palate.



FIG. 33.—Case VIII. Showing condition seven weeks after operation on palate, four weeks after operation on lip.



FIG. 34.—Case VIII. Showing contour of lip and nostril five months after second operation.



Even when the philtrum is quite small its development after this method of repair is most surprising and gives a much better appearing and functioning lip than those repaired by trimming the philtrum to a V shape and approximating the lateral lip margins beneath it. We used the latter method for several years and recommended its use in several of our earlier papers, but the contracted appearance of the resulting lips in many of the cases caused us to discontinue its use.

In bilateral harelip and cleft-palate the vomer is elongated and the premaxilla shows varying degrees of superior rotation with corresponding shortening of the columella. When the deformity is marked the premaxilla can be placed in approximately normal position either by resecting a V-shaped section from the under surface of the vomer to allow postero-inferior rotation of the premaxilla (Figs. 18 and 19), or in less marked deformities the vomer can be split antero-posteriorly on the inferior surface of the anterior portion, allowing a bilateral bulging of the sides when the premaxilla is forced downward and backward into position where it is held by a wire suture.

After reconstruction of the alveolar cleft—unilateral or bilateral—and repair of the harelip, a period of several months is allowed to elapse before operating upon the remaining cleft. Such remaining clefts, and also palates with clefts not extending through the alveolar process, are preferably corrected between the ninth and the twentieth month. During the past eighteen months we have done all palate cases in which the clefts extended as far anteriorly as the midportion of the hard palate in two stages—the operations being done from five to eight days apart. In the majority of these cases we have brought the rudimentary horizontal processes of the maxillæ and palate bones over with the soft tissues, using the bone from the side not attached to the nasal septum in unilateral cases, and from both sides in bilateral cases. Operations bringing bone over with the flaps were devised originally by Ferguson, used in Philadelphia for many years by J. Ewing Mears and later revived, improved and more successfully used by W. J. Roe.

Bringing the bone over with the flaps is probably a more difficult operative procedure than to use the muco-periosteal flaps only. The ultimate results, however, we believe are distinctly better in those cases having bone in the flaps, the palates being better formed, maintain greater length, and have better function. One fact which has kept the operation from being popular has been the too frequent detachment of the bone from the muco-periosteal flaps at the time of operation or else loosened to such an extent that it was subsequently lost. In such an event, if there is also failure of union of the mucoperiosteal portions, the necessary secondary operation is unquestionably more difficult and has less chance of being completely successful, than had mucoperiosteal flaps alone been used in the primary operation. However with our present technic of cutting and approximating the

flaps and routinely doing the operation in two stages, about one week apart, the bone is very seldom lost. The interval between operations allows time for the establishment of collateral circulation in the flaps which insures more certain and better union. (Figs. 25 to 30.) We prefer to have all the stages of harelip and cleft-palate operations completed before the child is two years old, since the cosmetic results and the quality of the speaking voice are best when the operations are done during that period. Gratifying results, however, are often obtained in older children or even in adults (Figs. 31 to 34), but the older cases are very apt to require longer training for the correction of the speech defect.

## PSEUDO-CARCINOMA OF THE STOMACH\*

SOME UNUSUAL LESIONS OF THE STOMACH RESEMBLING CARCINOMA

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EXPLORATORY operations on patients who seem clinically to have inoperable carcinoma of the stomach appeal very little to the average surgeon. The relatively high mortality of exploration in such patients, associated with the feeling of futility of such a procedure, may incline us to be ultraconservative in advising exploratory operation. In the great majority of instances our conservatism is justified. There is, however, a small group of middle-aged patients having unusual lesions of the stomach which resemble carcinoma clinically which upon exploratory laparotomy are found to have lesions other than carcinoma. In some instances these unexpected lesions are amenable to surgical relief. This group of patients may have palpable tumors of the stomach, or large X-ray filling defects of the stomach, or both, accompanied by symptoms which might well be those of carcinoma.

The importance of recognition of such a group is obvious, as is the necessity of embracing it in our indications for exploratory laparotomy.

The clinical histories of four patients presenting unexpected pathology of the stomach will be presented.

CASE I.—Mrs. H., aged fifty-nine, admitted October 1, 1925, to the service of Dr. George Dick. For a year the patient had had pain in the stomach which had been more or less constant. It did not seem related to food taking. The pain was worse at night. She vomited frequently, a thin, watery, brown fluid, which afforded her some relief. She had been very constipated and had noticed black stools. About seven months before she had become bed-ridden, due to weakness and extreme loss of weight. She had œdema of the ankles and was dyspnoëic. Her weight was about 75 pounds. The patient stated that about eighteen months before she had visited in central Illinois and while there had eaten a number of persimmons. She thought her trouble had dated from that time. This latter history was elicited after her operation.

On examination the patient was found to be extremely emaciated and dehydrated. There were no striking abnormalities found in the general examination, except in the abdomen. She was rigid in the epigastrium, especially on the left side, and the resistant abdominal wall felt suspiciously like a tumor mass in the region of the stomach, though a mass could not be outlined. Numerous examinations of vomitus showed no free acid, but from 24 to 36 combined acid. An Ewald test-meal showed free hydrochloric 11, combined acid 22. There was no blood, sarcinæ, or Oppler-Boas bacilli in the stomach contents. The urine was negative. The blood Wassermann reaction was negative. A blood examination showed hæmoglobin 62 per cent.; red blood-cells 2,650,000; white blood-cells 10,500. Stool examination showed no blood. A fluoroscopic examination of the stomach revealed a large, penetrating lesion, about 3 cm. in diameter, on the lesser curvature. The stomach showed a large residue at the end of five hours. Films showed a penetrating ulcer on the lesser curvature. (Fig. 1.) The X-ray diagnosis was penetrating ulcer, most probably malignant.

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\* Read before the Western Surgical Association, December 9, 1927.



FIG. 1.—Case I. Persimmon seed ball, with penetrating ulcer of lesser curvature of stomach



FIG. 2.—Hodgkin's infiltration of pyloric region of stomach.

## PSEUDO-CARCINOMA OF THE STOMACH

Operation was performed under local anesthesia on October 4, 1925. The stomach lay rather high under the ribs and on palpation seemed to be the seat of a large tumor involving nearly the whole stomach. With some difficulty the stomach was delivered into the incision, when it was found that the large mass was a foreign body in the stomach. Due to firm adhesions uniting the stomach and the under surface of the liver manipulation was difficult. An incision four inches long was made into the stomach, dividing the anterior surface transversely. A foreign body, black, rather smooth on the surface, and measuring about 4 by 5 by 3 inches was removed. This foreign body was about the size and shape of half a building brick. After this mass had been cut open it was found to consist of semi-solid debris interspersed with several persimmon stones, and some material which looked like persimmon skins. The outer covering of the foreign body was about 2 mm. thick, was very hard, and when struck with a hard instrument sounded like striking on wood.

On the lesser curvature was a large penetrating ulcer, the base of which was found adherent to the under surface of the liver.

The incision in the stomach was closed. After removal of the foreign body it was impossible to pull the stomach down sufficiently to do a posterior gastro-enterostomy, so an anterior gastro-enterostomy, with a side-to-side anastomosis between the loops of jejunum was made.



FIG. 3.—Case II. Mrs. G.—Photomicrograph of Hodgkin's infiltration of stomach.

Post-operatively, the patient continued to vomit occasionally and refused to eat. Owing to her extreme emaciation a jejunostomy was done three weeks after the first operation. A catheter was buried in the jejunum, and the jejunum was attached to the anterior abdominal wall. The patient improved after this procedure, but five days after the jejunostomy had been performed the catheter was inadvertently pulled out. The interne, who was called, tried to reinsert it into the jejunum, but instead of putting it into the bowel it was inserted into the free peritoneal cavity, with a resulting fatal peritonitis.

A post-mortem revealed a suppurative peritonitis, a healed incision in the stomach, and a large penetrating, non-malignant ulcer of the lesser curvature.

*Comment.*—While most of the text-books do not refer to phytobezoar, or persimmon food ball, Hart<sup>1</sup> has reported six cases from central Illinois where persimmon seed food balls were found in the stomach at operation. These masses varied in size from two to three inches to one which filled the entire stomach. In two of his patients ulcer of the stomach was an accompanying lesion. These food balls resemble the hair balls found in the stomach, and the shellac concretion found in patients who have drunk shellac

as a beverage. The food balls formed about persimmon seeds are thought to be originated by a gum which is found in the persimmon, which agglutinates food about it. In addition to the six cases Hart reported, he was able to find but five others reported in the literature.

CASE II.—Mrs. G., aged fifty. For three months before entering the hospital the patient had had vague abdominal distress and increased gas formation. She thought



FIG. 4.—Case III. Mrs. B.—Sarcoma of greater curvature of stomach.

she could feel a lump in the stomach. There had been no vomiting and only slight loss in weight.

Upon examination a small, hard mass was felt in the right epigastrium. Clinical blood was repeatedly found in the stool. An Ewald meal showed total acid 55, free hydrochloric acid 39, and a small amount of chemical blood. A blood examination showed haemoglobin 84 per cent, red blood-cells 4,580,000; white blood-cells 8300. An X-ray examination of the stomach showed a constant defect in the antrum reaching up to the pyloric ring. There was no obstruction to free passage of the barium to the pylorus. Films showed a filling defect of the pyloric antrum. (Fig. 2.)

A diagnosis of carcinoma of the stomach was made and an exploratory operation was performed by Dr. Dean Lewis. A large tumor mass on the greater curvature, with enlarged glands in the neck, mediastinum and peritoneal cavity, which have receded under good recovery.

FIG. 5.—Case III. Mrs. B.—Cross specimen of sarcoma of stomach.

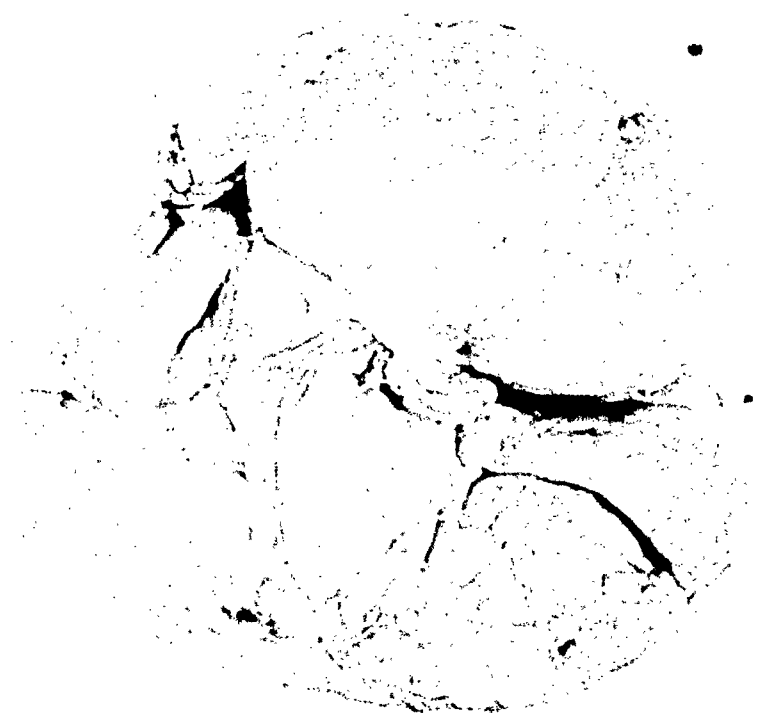


FIG. 6.—Case III. Mrs. B.—Photomicrograph of spindle-celled sarcoma of the stomach.



Microscopic examination of the specimen showed a diffuse infiltration of the mucosa and muscularis with round cells and new connective tissue. (Fig. 3.) A diagnosis of Hodgkin's disease was made.

The subsequent history of the patient has been interesting because she has developed enlarged glands in the neck, mediastinum and peritoneal cavity, which have receded under X-ray therapy. A few months ago she began having blood in the stools. I examined her at this time and a lesion somewhat narrowing the rectum was found in the ampulla. This was an ulcer, with indurated base but with no crater, which bled slightly on touch.



FIG. 7.—Case IV. Miss H.—Inflammatory fibromatosis of stomach.

The patient refused a biopsy of the tissue, but this lesion was probably also a Hodgkin's infiltration.

This seemingly primary involvement of the stomach by Hodgkin's disease is not common, but there are numerous examples in the literature as well as instances of primary involvement of the stomach by lymphosarcoma and leukemia.

CASE III.—Mrs. B., a patient of Doctor Bevan's. As a detailed description of this case is to be given elsewhere by Doctor Bevan, only a brief statement of the main features will be given. The patient was forty-eight years of age and for the past three and a half months had had nausea, without vomiting. She had had several gastric hemorrhages, the last one so severe that she fainted. She had felt a tumor in the epigastrium during the past month.



## PSEUDO-CARCINOMA OF THE STOMACH

Examination of the patient was negative, except for the finding of a tumor about the size of two fists directly under the umbilicus. The blood examination showed hemoglobin 42 per cent.; red blood-cells 4,030,000; fluoroscopy of the stomach showed that the barium entered along the lesser curvature but leaving a large filling defect of the greater curvature. (Fig. 4.) The abdominal mass was felt projecting into this defect in the stomach. There was no obstruction of the pylorus. The X-ray diagnosis was tumor of the stomach, probably carcinoma.

Operation by Doctor Bevan.—A pedunculated tumor projecting from the greater curvature of the stomach was found, which connected with a tumor on the inside of the stomach, which almost filled the stomach cavity. Part of the tumor was intra-gastric, lying under the mucosa, and part subserous, lying free in the abdominal cavity. No glands were palpably enlarged. A transverse incision was made in the anterior wall of the stomach and the tumor was stripped away without opening the mucosa of the stomach.

*Pathology.*—The tumor looked grossly like a large lipoma (Fig. 5), but on microscopic examination was found to be a spindle-celled sarcoma. (Fig. 6.)

*Comment.*—Primary sarcoma of the stomach is a rarity but in the reported cases it has taken its origin in the submucosa, muscularis, or subserosa, forming a

large, broadly attached tumor, or one which is pedunculated, lying mostly outside of the stomach. These sarcomata have little tendency to ulcerate and their course has been relatively benign. Farr<sup>2</sup> has reported a case of penetrating ulcer of the stomach which upon histological section was found to be sarcoma.

There is a rather large group of myomata of the stomach reported which have varied in structure, and which potentially may become sarcomatous. This group included liomyoma, adenomyoma, and fibromyoma.

CASE IV.—Miss H., aged sixty-four, was referred by Dr. George Dick. The patient complained of weakness, indigestion, regurgitation of food after eating, burning sensation in the upper abdomen, dizziness, excessive gas formation, and a loss of ten pounds in weight during the past year. The above symptoms have developed during the

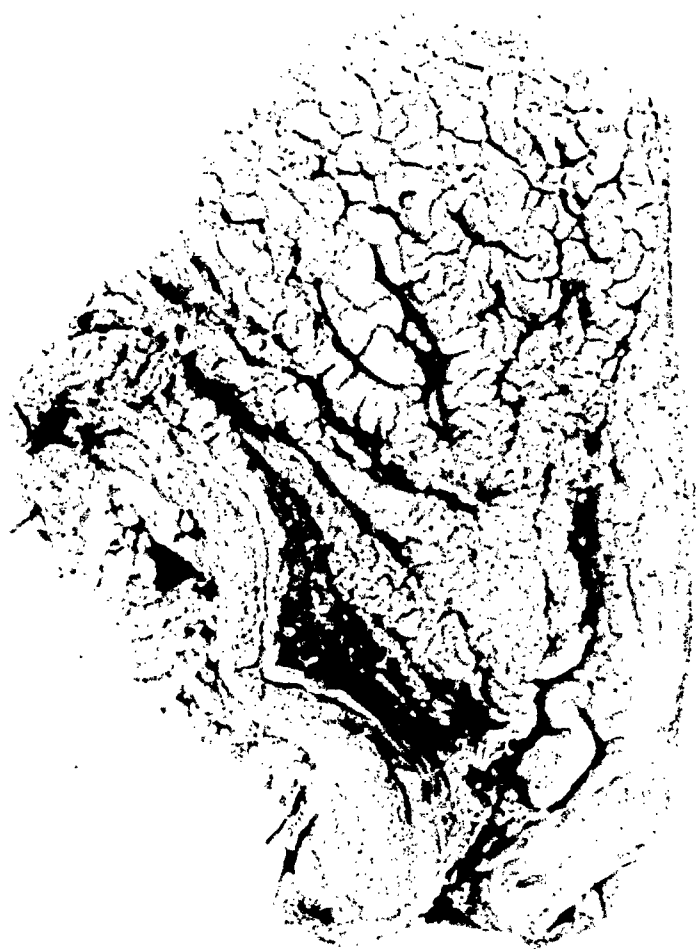


FIG. 8.—Case IV. Cross specimen of inflammatory fibromatosis of the stomach without ulceration of mucosa.

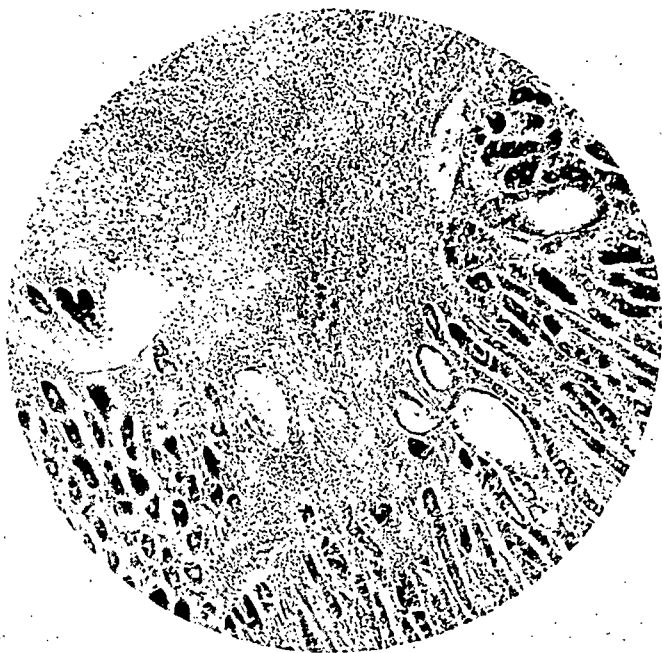


FIG. 9.—Case IV. Inflammatory fibromatosis of stomach. Photograph of section through mucosa and submucosa show round-cell infiltration.

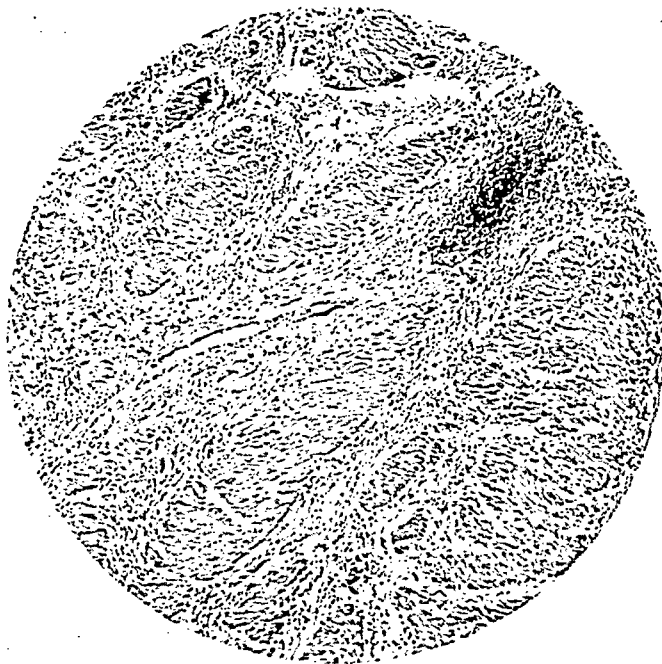


FIG. 10.—Case IV. Inflammatory fibromatosis of stomach. Photograph of section through muscularis.

## PSEUDO-CARCINOMA OF THE STOMACH

past fourteen months. In the past history the patient stated that she had had a Pott's disease of the upper lumbar spine when she was four years of age and this resulted in a marked kyphosis in the lumbar region. She had a hysterectomy for fibroids fifteen years ago.

The general physical examination revealed no marked abnormalities apart from the deformity. Her pulse rate was 100. A blood examination showed haemoglobin 78 per cent.; red blood-cells 4,000,000; white blood cells 8000. Her blood-pressure was 156 and her blood Wassermann reaction was negative. The urine was negative. An Ewald meal showed hydrochloric 32, total acid 53. Microscopic and chemical blood was present. A motor meal showed that the stomach emptied in practically normal time. A stool examination revealed chemical blood. A fluoroscopic examination of the stomach showed that the antrum was markedly narrowed, for a distance of four inches from the pylorus. This deformity remained constant. The stomach emptied rapidly. There was a good duodenal cap. The films showed canalization of the antrum. (Fig. 7.) The diagnosis was almost surely carcinoma.

An exploratory laparotomy was done in February, 1927. The pyloric antrum, including most of the lesser curvature and about one-half of the greater curvature, was the seat of a hard tumor mass which roughly maintained the outline of the stomach, but which had converted the wall of the stomach into a contracted, hard, tubular mass. This indurated area stopped abruptly at the pylorus. The

stomach was freely movable and there were no enlarged regional glands. The serosa of the stomach was bright and glistening, but appeared to be traversed by subserous, fibrous strands which were indistinctly seen beneath the serosa.

A Billroth II resection of the stomach was carried out, removing somewhat over one-half of the stomach.

The gross specimen (Fig. 8) when cut open showed that in the affected portion of the stomach there was no gross ulceration of the mucosa. The mucosa was thrown up in coarse, heavy longitudinal rugae. The mucosa and submucosa was about 7 mm. thick through the tumor and about 4 mm. thick in the healthy stomach wall. On cut section the submucosa was seen to be much thickened and was gray and fibrous in appearance.

*Histology.*—Beginning directly under the mucosa was an extensive round-cell and connective-tissue infiltration (Fig. 9), which was most marked in the submucosa but which separated the muscle bundles of the muscularis and to a lesser degree was present in the subserosa. (Fig. 10.) The borderline between serosa and muscularis was not distinct, due to the widespread formation of connective tissue. The submucosa made up about one-half of the thickness of the stomach wall and consisted of round-cell infiltration and connective tissue. In these round-cell accumulations there were numerous



FIG. 11.—Case IV. Inflammatory fibromatosis of stomach. Photomicrograph of section showing the character of the cells.

large mononuclear eosinophile cells. The muscularis mucosa was not everywhere distinct, though there was no evidence of breaking through it by the epithelium. The mucosa was everywhere intact and was not ulcerated. There was no microscopic evidence of carcinoma.

No area in the sections looked at all like tuberculosis or syphilis.

*After-history.*—The patient has gained in weight and is practically free from symptoms. Occasionally she has regurgitated small amounts of food. She is unable to eat as much at a time as she was able to prior to the onset of her illness.

*Comment.*—Obviously this lesion falls in the category of linitis plastica, or leather bottle stomach. As has been so frequently pointed out in the literature, either chronic inflammation, as syphilis or tuberculosis, idiopathic fibromatosis, or fibrocarcinoma may give the picture of linitis plastica. The majority of observers favor the view that most of the cases are carcinoma of an unusually fibrous type. Kirby Dwight<sup>3</sup> has recently said that linitis plastica stands as sort of a "no man's land" between the obviously malignant and the plainly benign cases of hypertrophic induration of the stomach wall. Ewing<sup>4</sup> is of the opinion that most if not all of these diffuse cirrheses of the stomach are atypical fibrocarcinomata. He states that it has long been known and has been specifically noted by Rokitsansky and Kaufmann that the epithelial cells in schirrous carcinoma of the stomach may be reduced to a minimum, or may largely disappear, so that a very careful microscopic examination is required to detect traces of carcinoma. Lyle<sup>5</sup> made a careful review of the literature and concluded that of 126 cases he collected 68 were benign and 58 were malignant. It must be remembered that some cases reported as benign have on subsequent examination been found to be malignant.

In the case here reported syphilis could be excluded by reason of an absence of history of this disease, a negative Wassermann reaction, and the important fact that microscopically there was no evidence of gumma formation or endarteritis.

While the patient had been afflicted with a severe tuberculous bone disease in childhood, there was no evidence of tuberculosis of the stomach either grossly or microscopically.

As to the diagnosis of fibrocarcinoma, it can only be said that examination of repeated sections failed to show carcinoma cells, and that there was no evidence of ulceration of the mucosa. In addition, there was no enlargement of the regional glands and no known metastases.

This deformity of a circumscribed, indurated lesion of the stomach showed a fibromatosis of all layers except the mucosa, with areas of round-cell infiltration, and until evidence to the contrary is available the lesion must be regarded as a benign inflammatory fibromatosis.

In conclusion, it may be emphasized that:

1. Foreign bodies in the stomach, as hair balls, food balls or shellac balls;
2. Chronic granulomata, as Hodgkin's, leukæmia or lymphosarcoma;
3. Chronic inflammatory lesions, as syphilis, which may be ulcerative or cirrhotic, and primary tuberculosis, which may be ulcerative or fibrous (Severin)<sup>6</sup>;

## PSEUDO-CARCINOMA OF THE STOMACH

4. Tumors other than carcinoma, as sarcoma, and the benign tumors, as myoma, adenoma, papilloma, haemangioma and,

5. Inflammatory fibromatosis, which may ultimately be classified as typical fibrocarcinoma, may all be easily confused with the usual carcinoma of the stomach, and should be carefully excluded before exploratory operation is denied a patient apparently suffering with inoperable carcinoma of the stomach.

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# TREATMENT OF ULCER OF THE STOMACH AND DUODENUM

A PLAN BASED ON THE CLASSIFICATION OF PATHOLOGIC TYPES

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FROM THE DEPARTMENT OF SURGERY, DECOURCY CLINIC

THE first step in the intelligent treatment of gastric and duodenal ulcers is a classification of their pathologic types, for the various conditions coming under the common heading of peptic ulcer are so diverse that no one form of therapy could be hoped to suffice for them all. The simple ulcer of the gastric mucosa, for example, will usually yield to medical measures which would be futile in the case of the chronic indurated ulcer. To be most efficient, the treatment of gastric or duodenal ulcer must therefore be varied according to the pathologic condition found in the individual case.

No classification of peptic ulcer will ever be wholly satisfactory until we understand more fully the etiology of this lesion. At the present time, our knowledge of this subject is largely fragmentary and conflicting. Of recent years much stress has been laid upon focal infection, particularly with streptococci having an elective affinity for the stomach and duodenum, such as those described by Rosenow. Nicotine, too, must have a toxic action on the stomach by virtue of its cumulative action; for many of us have experienced heartburn, the symptom of acidity, following even the moderate use of tobacco.

A most important factor leading to peptic ulcer, if only an indirect one, is the daily abuse of the stomach. Next to the genitals, the stomach is probably the most abused organ in the body. Human intelligence has not yet reached the high stage at which judgment predominates over the cravings of the physical appetites. As we inquire carefully into the histories and habits of a large group of patients with gastric and duodenal ulcer, we cannot escape the conclusion that the daily abuse of the stomach is a most important contributory cause.

The only absolute fact we have with regard to the causation of peptic ulcer is that the lesion coexists with a very acid gastric juice. To be sure, an occasional case is encountered in which acidity is normal or subnormal; but, even in these exceptional instances, it is probable that hyperacidity was present at some time or other. As the acid gastric juice is the principal obstacle to the healing of ulcers, much of our medical and surgical treatment is based on the alleviation of this symptom and the protection of the ulcer from its ill effects.

*Classification of Peptic Ulcers.*—Because of our inadequate knowledge of the etiology of gastric and duodenal ulcer, a hard and fast classification is impossible. However, the following simple grouping will be found convenient, principally as a guide to the selection of proper treatment:

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1. Ulcer of the mucosa. 2. Ulcer of the submucosa. 3. Ulcer of the entire wall. 4. Indurated ulcer. 5. Delaminating ulcer, *a*, with stenosis; *b*, without stenosis.

Ulcers extending no deeper than the mucosa do not require surgical attention. One may confidently expect them to yield to a proper medical régime within a comparatively short period of time. If the symptoms and positive röntgenologic findings persist after several weeks of careful medical treatment, the condition is probably not a mucosal but a submucosal ulcer.

As one reads the literature on gastric and duodenal ulcer, he comes across many references to the failure of medical treatment. But such statements mean nothing, unless the writer specifies how medical treatment was administered; whether the patient was confined to bed or allowed to attend to his business; whether the diet was correctly prescribed, and in sufficient detail; and whether, if correct diet was ordered, the patient followed his instructions religiously. Obviously the term "medical treatment" for peptic ulcer may cover a multitude



FIG. 1.—Incision in stomach.

of therapeutic measures, and it is necessary to be specific in each instance. Even the classical Sippy diet has been so varied by individual gastro-enterologists that the term no longer has a uniform significance. And we have no right to call the treatment in a given case a "medical failure," until we have been assured of its thoroughness.

On the other hand, we must not accept "medical cures" as such merely because the symptoms have been alleviated or even removed completely. We must inquire into the degree of improvement shown on röntgenologic study and also keep the patient under observation for some time in order to be sure that the relief is permanent. The terms "medical failure" and "medical cure" have led to much confusion and should not be used without careful discrimination.

Submucosal ulcers are much more refractory to medical treatment than those involving only the mucous membrane. Although they sometimes heal under medical measures, it has been my experience that surgical intervention is frequently required. However, medical treatment for several weeks with the patient in the hospital must always be given a fair chance before surgery is justifiable.

*New Treatment for Submucosal Ulcers.*—Of recent years I have been obtaining excellent results with a new procedure for submucosal ulcer, designed specially to meet the conditions found in this type of lesion. The operation consists essentially in gastro-enterostomy plus cauterization of the ulcer from within the stomach.

The ulcerated area is reached and treated as follows: Following the posterior gastro-enterostomy, the abdominal cavity around the stomach is packed with warm gauze pads. When this step is completed, the assistant picks up a fold of the anterior wall of the stomach. This fold is incised in a direction at right angles to the long axis of the organ. As soon as the stomach is opened, a suction tube is inserted and the organ emptied. Under thorough illumination with a light in the stomach, the mucous membrane is carefully explored and the ulcer located. The edges of the stomach are then held apart with Ellis forceps and the ulcer thoroughly cauterized with the actual cautery. This stage of the operation is completed by closing the stomach with catgut in the usual manner.

With this procedure my operative results have been excellent. And it has led me to observe that multiple ulcers are much more common than is sometimes supposed. By means of a thorough inspection of the mucous membrane of the stomach under direct illumination, I have frequently found several ulcers in cases in which the existence of more than a single ulcer was not suspected.

From my experience I believe that gastrojejunal ulcers following gastro-enterostomy occur much less frequently when the entire ulcer base is cauterized in the manner that I have advocated and all the ulcers are found. The sterilization of the ulcer bases by cauterization is probably the important factor in bringing about this immunity. It is quite probable that many gastrojejunal ulcers following gastro-enterostomy are due to secondary infection arising from infected ulcers overlooked either in whole or in part at the time of operation. When the ulcer is cauterized from outside the stomach, as in the Balfour operation, the operator may fail to destroy the entire ulcer, inasmuch as the base is frequently very large; furthermore, he may easily overlook a non-palpable ulcer.

It is possible that the etiology of gastrojejunal ulcer is the same as that of the kissing ulcer described by Moynihan; that is, an ulcer on the anterior wall of the stomach exactly opposite the original ulcer on the posterior wall. In other words, direct contact and consequent infection may be the important factor in the causation of gastrojejunal ulcer. In that event, sterilization of all ulcers in the stomach after gastro-enterostomy should be considered an essential part of surgical treatment.

A further advantage of the procedure I have recommended over the Balfour operation is the fact that it eliminates all suturing over infected area.

*Gastric Resection for Indurated Ulcer.*—For the types of ulcer with induration, and also those that cause constriction or delamination, I believe



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that resection of the stomach is preferable to gastro-enterostomy. Most ulcers involving the entire wall of the stomach or duodenum are necessarily indurated and therefore belong to this category.

My principal justification for this apparently drastic treatment lies in the fact that many workers, particularly those at the Mayo Clinic, have demonstrated early malignant changes, microscopically visible, in the edges of many calloused ulcers of this type; in the high frequency with which we encounter inoperable carcinoma of the stomach; and in the not uncommon occurrence of malignant disease following so-called conservative operations for peptic ulcer. According to Eusterman and Bueermann,<sup>1</sup> every gastric

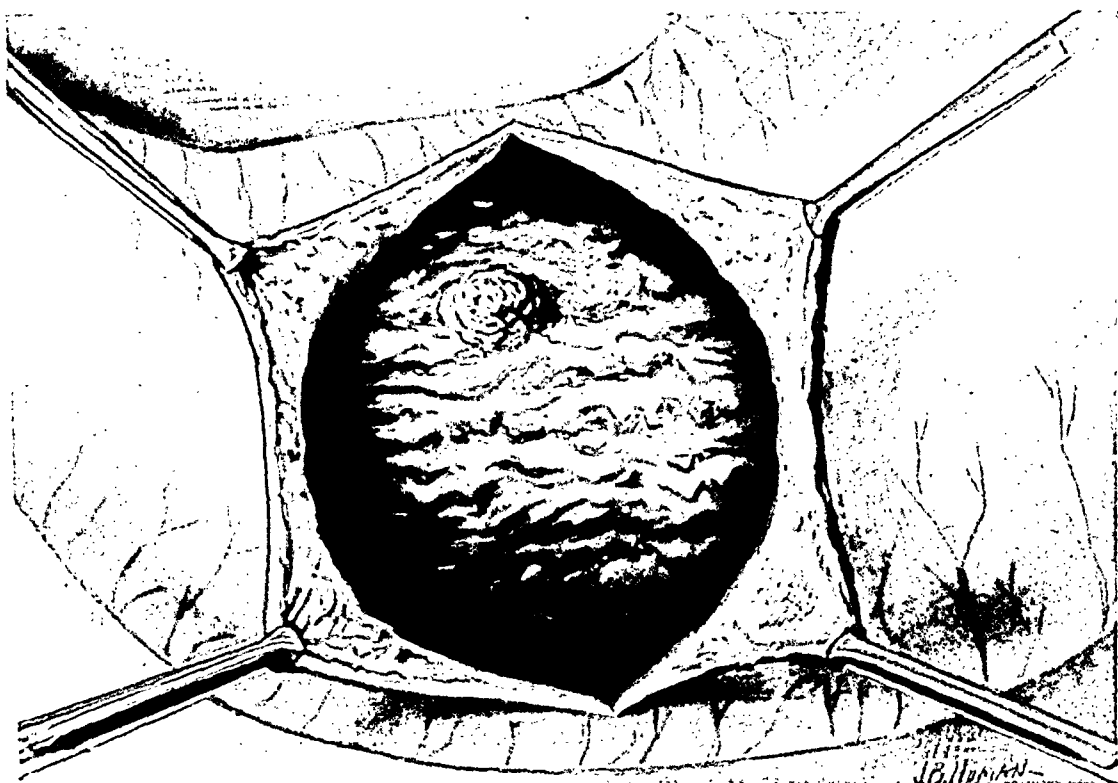


FIG. 2.—Exposure of ulcer.

ulcer may, for practical purposes, be regarded as a potential carcinoma and a number of gastric lesions having many of the gross clinical and röntgenographic characteristics of benign ulcer are actually carcinomatous. Other unfortunate sequelæ of the time-honored gastro-enterostomy are gastrojejunal ulcer and gastrojejunocolic fistula, although I believe these complications to be avoidable.

On the other hand, it must be admitted that with present-day technic the mortality for gastric resection is higher than for gastro-enterostomy. Even in the hands of the best surgeons in various centres of the world, I feel that the present mortality from this operation is almost prohibitive, not to mention the unnecessary deaths that will follow when the operation is performed by inexperienced men who feel that they also can do whatever they have seen others do. But it must be remembered that the subject of gastric resection

is still in its infancy and that future technical improvements will probably do much to improve the safety of this operation.

It was not so long ago that cholecystectomy was recommended to take the place of cholecystostomy for chronic infections of the gall-bladder. Originally this suggestion met with strong opposition, and the principal objection of its opponents was the higher mortality. Yet to-day the technic of cholecystectomy has been so greatly improved that the mortality is just as low as that of cholecystostomy and the morbidity is much lower.

When thyroidectomy was first performed some years ago, the mortality was staggering; to-day we can count it as below that of most other major operations.

It is to be hoped that the history of resection of the stomach will soon follow the path of cholecystectomy and thyroidectomy. With proper selection of cases not allowed to advance too far, conscientious preliminary treatment, improved and more careful operative technic and thorough after-treatment, we may soon find gastric resection within realm of safe surgery.

*Concerning Operative Technic.*—In all operations for gastric or duodenal ulcer, I regard the preliminary treatment as of great importance. My practice is to keep the patient in the hospital for three or four days preceding the operation. During that period, a diet of high caloric value but requiring a minimum of digestive activity is allowed. The feedings are small in amount but given at frequent intervals. On three successive days before the operation and immediately before he is taken to the anæsthetizing room, the patient receives a gastric lavage with warm saline solution. Just before the operation he is given a large amount of fluid by mouth and also by hypodermoclysis under the breast. On the second night before operation, a cathartic is administered.

A large number of operations for gastric and duodenal ulcer have been reported in the literature. In order to formulate our own technic, which should vary according to conditions found in the individual case, it is well to have a knowledge of many of them.

Judd<sup>2</sup> believes that, in the treatment of duodenal ulcer, combined excision and partial duodenectomy have definite advantages over gastro-enterostomy. The anterior half of the pyloric sphincter, together with the cap of the duodenum and the ulcer, is excised. When this portion of the duodenum has been removed and the anterior part of the sphincter excised, two openings, one at the lower end of the stomach and the other at the upper end of the duodenum, stand out. They resemble the openings of a gastro-enterostomy after the posterior row of sutures has been placed. While this operation is not technically difficult, Judd does not recommend it in cases in which the ulcer is located a considerable distance down the duodenum or in which the duodenum is too firmly fixed to be readily mobilized.

In operating for duodenal ulcer, Pannett<sup>3</sup> prefers partial duodenectomy to gastro-enterostomy. He is impressed with the fact that the results of gastrojejunostomy are far from satisfactory and that a better technic is

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needed for handling these cases. In the present state of our knowledge, however, partial duodenectomy cannot be used for the treatment of all cases of duodenal ulcer.

In the surgical treatment of ulcer of the stomach, Carter<sup>4</sup> resects the lesser sac of the stomach including the pylorus, performs a gastrojejunostomy by suturing the entire width of the stomach into the longitudinal opening and the distal half of the jejunal loop and closes the anterior wall of the lesser sac by attaching the gastrohepatic omentum to the lesser curvature of the stomach and the convex surface of the jejunum and the gastrocolic omentum to the proximal and distal loops of the jejunum and greater curve

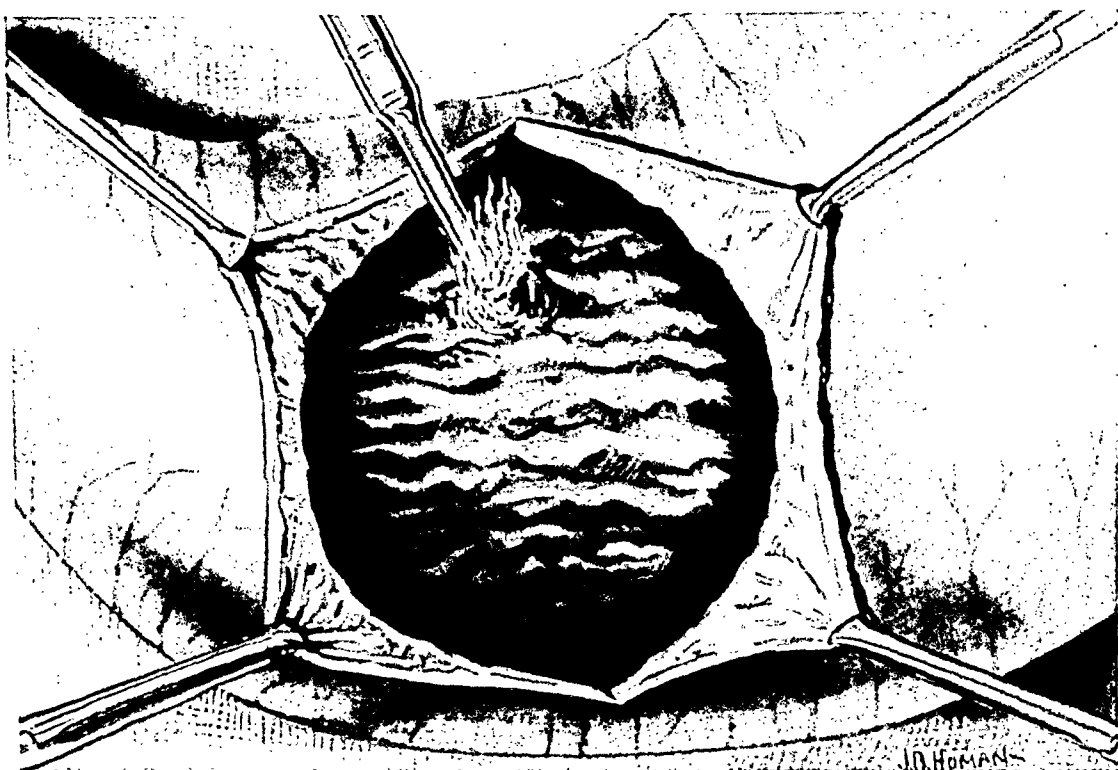


FIG. 3.—Cauterization of ulcer.

of the stomach. By this means he fixes the jejunum in position and maintains the normal anatomic position of the stomach.

When the ulcer is confined to a small area of the pylorus, I prefer complete closure of the distal end of the stomach with posterior gastrojejunostomy. If the ulcer is so extensive as to require removal of a large portion of stomach, suturing of jejunum to the resected portion of stomach is to be preferred. However, occasional deviations from this rule are necessary.

The mortality from resection of the stomach has been lowered not so much by a diversity of operative methods as by more careful technic, particularly in the closure of the duodenum. In my<sup>5</sup> observation, careless closing of the duodenum has resulted in a number of unnecessary deaths and I consider this neglect an important factor in the mortality from operations for peptic ulcer. My practice is to invaginate the duodenum with a purse-

string suture rather than to suture it with over-and-over stitches. If the duodenum cannot be freed sufficiently to use a purse-string suture, I prefer to limit the operation to a gastro-enterostomy. Lahey is credited with the statement—and I agree with him—that it is better to leave a duodenal ulcer untreated and close the intestine adjacent to the stomach rather than to risk an incomplete closure of the duodenum.

As in the operations for the radical cure of hernia, it is not the new operation so much as the better technic for those that we have that is needed in the case of resection of the stomach.

From 1916 to 1920 I performed seventy-nine gastro-enterostomies and no gastric resections for ulcer of the stomach or duodenum; from 1920 to 1923, twenty-four gastro-enterostomies, fifty gastro-enterostomies plus cauterization of the ulcer from the outside, eight resections of the stomach for ulcer, and five for cancer. From 1923 to date, I have performed gastro-enterostomy plus cauterization of the ulcer from within the stomach in thirty-four cases; resection of the stomach for indurated ulcer, in twenty-nine. These figures indicate the change that has taken place in the treatment of peptic ulcer during the past ten years, and I feel that the statistical averages of a great many other clinics will correspond with my own. My belief is that with more careful technic along the lines that I have indicated, the ultimate end results will become much better and the immediate mortality much lower.

*Selection of Cases.*—In the Clinic we have devised a set of rules for general guidance with regard to the treatment for different types of gastric or duodenal ulcer. Of course, these rules are subject to deviation according to conditions found in individual cases.

In general, the following policy is followed at the Clinic:

(1) In persons under thirty years of age with gastric or duodenal ulcer, surgery should be advised only after careful medical treatment has failed to give permanent relief.

(2) In persons past thirty with indurated ulcer, surgery is indicated immediately the diagnosis is made, because of the constant danger that malignancy may develop from the base of the ulcer.

(3) In uncomplicated ulcers, particularly in persons under the age of forty, gastro-enterostomy plus internal cauterization of the ulcer is the method of choice.

(4) In persons with indurated ulcers, particularly those past forty years of age, resection of the stomach should be performed. Exceptions to this rule may be taken when the condition of the patient does not warrant so extensive an operation.

#### CONCLUSIONS

1. While focal infection undoubtedly occupies a definite rôle in the etiology of gastric and duodenal ulcer, we must not overlook the important part played by the daily abuse of the stomach.

2. Peptic ulcers may be classified as follows: (a) ulcer of the mucosa,

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(b) ulcer of the submucosa, (c) ulcer of the entire wall, (d) indurated ulcer, and (e) delaminating ulcer with or without induration.

3. A new operation for the treatment of submucosal ulcers is described. It consists essentially in gastro-enterostomy plus cauterization of the ulcer from within the stomach.

4. It is possible that gastrojejunal ulcers following posterior gastro-enterostomy are due to contact infection from the original ulcer, as in the case of the kissing ulcers described by Moynihan.

5. The ultimate operation for indurated ulcers, particularly in older patients, will probably be partial gastrectomy.

6. Careless closure of the duodenum is an important factor in the mortality.

7. In patients under thirty, medical treatment should be given a thorough trial before operation is advised.

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# INTUSSUSCEPTION OF THE SMALL INTESTINE INTO STOMACH THROUGH A GASTRO-ENTEROSTOMY STOMA

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AND

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RETROGRADE intussusception of the small intestine following gastro-enterostomy has, in contrast to the total number of gastro-enterostomies done, a very small per cent. of occurrence. In the practice of many active gastro-intestinal surgeons, it has never occurred, at least to be diagnosed by them or by the patient himself, as anything more than an ordinary acute gastritis. However, in 1924, Drummond reported a case, and was able to obtain reports of thirteen others in the literature. Further reference to the literature has enabled us to add nine additional case-reports to those given by Drummond, which, with the one we ourselves present in this paper, gives a total of twenty-four.

As suggested by Kopp,<sup>6</sup> the importance of the proper recognition of this complication is evidenced by the fact that six of seventeen cases then recorded ended fatally, and it is for that reason that we are presenting our case, and summarizing the knowledge which examination of the cases on record is able to give us.

**CASE REPORT.**—A woman, aged forty-one, housewife by occupation, was seen by us July 29, 1925, at 8 P.M., her chief complaint being persistent vomiting of three days' duration. Seven years before she had been operated upon for chronic appendicitis and a right ovarian cyst. Six months later, a gastro-enterostomy for a duodenal ulcer had been done. For two years prior to the gastro-enterostomy the patient had been suffering with nausea and vomiting of blood-tinged material, and epigastric pain coming on twenty to thirty minutes after meals. There had been considerable loss of weight during this time.

The symptoms complained of before the gastro-enterostomy was done were relieved, but had been replaced by a chain of symptoms related to the stomach and occurring with each menstrual period. These were characterized by epigastric discomfort, dull in type and diffuse over the upper abdomen; and general malaise, headache, anorexia and nausea coming on twenty to thirty minutes after eating, and accompanied by vomiting. The vomitus consisted of dark brown material, coffee-ground in type, and very foul smelling. Between these monthly attacks she felt quite well, was up and about, and was on a general diet. During the past two years her weight has decreased from 158 pounds to 102 pounds.

**Present Illness.**—On July 27, at 7 P.M., two days before being seen by us, the patient suddenly became nauseated and began to vomit. During the two previous days she had eaten heartily of crab meat and other seafood. The vomiting persisted, and at first was undigested food material, but later became dark brown and very foul smelling. The pain was paroxysmal in type, occurring about every ten minutes, and was confined to the upper abdomen. The bowels moved several times, the stools being thin and dark brown, with a foul odor.

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*Physical Examination.*—Middle-aged white woman, lying in bed, and vomiting every five minutes. The vomitus is dark brown and coffee-ground in type. She cries out with abdominal pain every three or four minutes, despite a large dose of morphine given three hours before.

The facies are pinched, the forehead and extremities cold and clammy. The radial pulse is almost imperceptible, but when obtained is ranging around 120 per minute and regular. The temperature is 97. The systolic blood-pressure is 78 millimetres of mercury, the diastolic 60 millimetres. Despite the severe degree of shock, the mucous membranes and the finger tips are of good color. The mucous membranes of the mouth are very much patched and dehydrated.

The head, neck and chest are negative.

*Abdomen.*—The scars of the two former operations are seen; one in the upper midline and one in the lower midline. Both are well healed and there is no hernia in either. Just to the left of the umbilicus and slightly above it, there is a rounded prominence of the abdominal wall. There is no discoloration of the skin over this area. No peristaltic waves are seen at the time of examination, but they had been seen four hours previously by Doctor Burch, the patient's family physician.

Neither kidney, spleen or liver are palpable. No tenderness is noted over these areas. At the site of the prominence above mentioned, may be palpated a mass 15 cm. on a side, extending laterally, to the left of the midline, with its centre just above the level of the umbilicus. It is exquisitely tender and gives one the impression of being soft and mushy in consistency. There is marked muscle spasm over this region. The remainder of the abdomen is soft, and no tenderness and no masses are made out.

Normal peristalsis is heard over the lower abdomen, and is excessive over the epigastrium. Vaginal and rectal examinations not done.

At this time, a tentative diagnosis was made of high obstruction of the jejunum, the causative factor of the obstruction being a perforated gastrojejunal ulcer.

The patient was sent to the hospital in an ambulance, and during the next twelve hours was given 1000 c.c. of normal salt solution intravenously, two hypodermoclyses of 1000 c.c. each, and a transfusion of 500 c.c. of whole blood, together with external heat, morphia, adrenalin and caffeine sodium benzoate. She responded to this treatment, her mucous membranes lost their parched appearance, the face became fuller and brighter, the systolic blood-pressure came up to 128 mm., the temperature 99, and the pulse 96. In other words, the patient's condition improved so much that an operation could be undertaken, which, at the time of the first examination, was entirely out of the question, due to the extreme degree of shock. The vomiting and pain persisted, and the abdominal mass increased somewhat in size during these twelve hours.

Before the operation and transfusion, the red blood-cells were 4,500,000, white blood-cells 13,000; the urine showed one plus albumin and a few granular casts. The vomitus was positive for blood.

*Operation.*—July 29, 1925. Anæsthetic—ethylene, with novocaine infiltration of skin and fascia. The abdomen was opened through the upper left rectus region. This was directly over the mass. Several rather dense adhesions along the former upper incision were found and separated. The mass palpated before the operation was found to be within the stomach, and, upon lifting up the transverse colon and mesocolon, to expose the site of the former gastro-enterostomy, a hernia of the jejunum through the gastro-enterostomy stoma was found, and the mass within the stomach was found to be the œdematous jejunum.

Gentle traction, together with pressure from above, over the stomach, easily released the herniated jejunum, which was found to be a loop about 30 cm. in length, beginning 15 cm. distal to the site of the gastro-enterostomy. There was considerable œdema of this loop, with obvious vascular stasis, but no gangrene. The stoma of the gastro-enterostomy was 8 cm. in its long diameter. This was free of any induration or ulcer.

The duodenum and stomach were examined and found to be negative. The pylorus was patulous and no scarring or signs of the former ulcer were made out.

The other abdominal organs were negative.

After the herniated jejunum was freed, it was sutured to the transverse mesocolon, with the idea of preventing any recurrence. The question of cutting off the gastro-enterostomy at this time was considered, but was thought inadvisable on account of the patient's condition. The abdomen was closed in the usual way. The patient stood the operation very well, and left the operating room in excellent condition.

*Post-operative Course.*—The patient continued to vomit immediately after the operation, but the vomiting was relieved by a gastric lavage, done the night of the operation. Liquid food in small amounts at a time was started forty-eight hours after the operation, and was retained without discomfort. The bowels were moved with enemata, and the patient ran an uneventful post-operative course, leaving the hospital on the fourteenth day following the operation.

At the present time, which is two years after the operation, the patient's condition is excellent. She has had no return of the abdominal attacks, the digestion is good and her weight now is fifteen pounds more than it was at the time of the operation.

A personal talk with the surgeon who did the gastro-enterostomy brought out the fact that the stoma was made very much smaller than was found at this time, and the suggestion was made that the same condition of herniation of the jejunum into the stomach had occurred with each vomiting attack during the past several years. At these times, the jejunum had always released itself, until the present attack, but this repeated herniation had no doubt increased the size of the stoma.

*Etiology.*—That the presence of the gastro-enterostomy is of etiological significance in these cases goes without saying. The type of gastro-enterostomy is apparently of no effect on the occurrence of the intussusception. Drummond offers a possible explanation in that the presence of the stoma may make possible an occasional over-rapid emptying of the stomach, with at some time resultant irritation of the jejunal mucous membrane sufficient to cause anti-peristalsis. If this results in retrograde intussusception, efforts of the stomach to empty itself will only serve to further aggravate the condition. Kopp<sup>4</sup> is of the opinion that such attacks are of greater frequency than the literature would give one to believe, but that spontaneous reduction of the intussusception prevents a proper realization of the true nature of the condition. In our case, it is not hard to imagine that the attacks complained of prior to the final operation were in reality retrograde intussusception relieved by spontaneous reduction.

*Occurrence.*—Lewisohn's case occurred on the sixth post-operative day, but the usual onset is much later, from nine months to fifteen and one-half years. Drummond<sup>1</sup> gives seven years as the average.

*Symptoms and Diagnosis.*—With a history of previous gastro-enterostomy, retrograde intussusception should always be thought of in the event of sudden attacks of cramping pain in the upper abdomen attended by vomiting of food material and bile, and later of blood. Bloody vomitus is a symptom of every case in which the intussusception has carried the jejunum into the gastric cavity. The general condition of the patient goes rapidly down-hill, so that, as in our case, he is often in shock when first seen. Rigidity and distention of the abdomen, which we report, is not a constant



finding. A tumor in the upper abdomen is visible in approximately 50 per cent. of the cases. Leucocytosis and a rise of temperature are not present; blood-pressure is normal unless shock intervenes.

*Recurrence.*—Recurrence is reported in only one case, that of Baumann,<sup>11</sup> in which it took place eight weeks after the initial reduction and was relieved by resection of 10 centimetres of intussuscepted gut.

*Treatment.*—Treatment, in every case in which the patient's condition permits, is immediate operation. Measures, in addition to reduction of the intussusception, are at the jurisdiction of the individual surgeon, since no uniform treatment has been devised. If the duodenal ulcer is healed, the anastomosis of the gastro-enterostomy should be divided as this is the only certain way to prevent recurrence of the same condition.

## CONCLUSIONS

1. Retrograde intussusception following gastro-enterostomy has been reported in twenty-four instances.
2. The symptom complex is one of sudden acute upper abdominal pain, with vomiting, first of food, later of bile and blood. Visible peristalsis, rigidity and tenderness are possible but not constant factors. Shock is a frequent complication.
3. The time of occurrence after operation is usually a matter of years.
4. Treatment is immediate operation.

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# GASTRO-JEJUNO-COLIC FISTULA

AN UNUSUAL AND FATAL COMPLICATION FOLLOWING OPERATIONS  
FOR DUODENAL ULCER

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THE following case is reported because of the unusual complication of gastro-jejuno-colic fistula following a partial gastrectomy and pylorotomy for presumably a recurrent gastro-jejunal ulcer. Lahey,<sup>1</sup> in discussing gastro-jejunal ulcers, mentions their tendency to perforate into the transverse colon and Martin<sup>2</sup> describes such a specimen seen in one of the London museums. However, the formation of a large cloaca, communicating with the stomach, jejunum and transverse colon, is sufficiently rare to warrant the report of such a case. The patient was on the surgical service of Dr. Frank S. Mathews, to whom I am indebted for permission to use the clinical history.

CASE REPORT.—The patient was a white male, aged forty-six, who came to the hospital complaining of pain in the left upper quadrant of the abdomen of four days' duration. The majority of the following history was obtained from a letter brought by the patient from the surgeon who had operated on him two months previously. The patient was first operated upon in 1924 for a duodenal ulcer. The operation was gastro-enterostomy, cholecystostomy, and appendectomy. A year later he was operated upon for a marginal ulcer. At this time the gastro-enterostomy was undone and a jejunostomy was performed. This stoma never healed completely and continued to drain about a teaspoonful of amber-colored material each day. The gastric pain gradually returned and two months ago on September 24, 1927, he was operated on a second time for recurrent ulcer. At this operation a partial gastrectomy and pylorotomy were done with a gastrojejunostomy of the Polya type and an entero-anastomosis. Convalescence was uneventful and he returned home on October 14, 1927. He had been taking a dram of milk of magnesia daily, and had been free from pain. During the week before admission there had been no drainage from the jejunostomy.

Four days before admission the patient began to have discomfort in the left upper quadrant of the abdomen, close to the old jejunostomy. The pain came on gradually, increased in severity, and was of a colicky nature. It came day or night and was severe enough to cause his family physician to give him codeine. There was no nausea or vomiting. Black stools had been present for several days. In addition, there had been gnawing pains in the right upper quadrant of the abdomen, radiating to the back. The patient had perspired a great deal, but knew of no fever. He had had daily enemata with fecal return but had passed little gas.

Physical examination of the head, heart, and lungs showed no abnormality. The abdomen showed two well-healed scars in the upper right quadrant, one appearing older than the other. In the lower medial portion of the upper left quadrant there was a small sinus opening surrounded by an area of red skin. There was little distention and no fluid was detected. There was a marked tenderness throughout the entire upper portion of the abdomen. No masses could be felt.

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## GASTRO-JEJUNO-COLIC FISTULA

A plain X-ray film of the abdomen, done November 7, 1927, showed only gas-filled distended intestines. The following report is made by Dr. Percy Brown from a gastro-intestinal barium X-ray series begun on November 15, 1927.

"The fluoroscopic findings in this case are extraordinary. Evacuation takes place from the stomach by what seems to be three passages: (1) pylorus, (2) stoma into the ileum, (3) stoma into the jejunum.

"The passage by the pylorus is much more rapid than is usually seen in situations wherein artificial stomata have been produced. Through the passage evidently passing into the jejunum, it sometimes appears as if the content were progressing in the inverse direction. A satisfactory explanation of this phenomenon cannot be arrived at. The general evacuation of the stomach is rapid, although there is a moderate degree of residue obtaining, possibly in the immediate vicinity of the artificial openings. In a

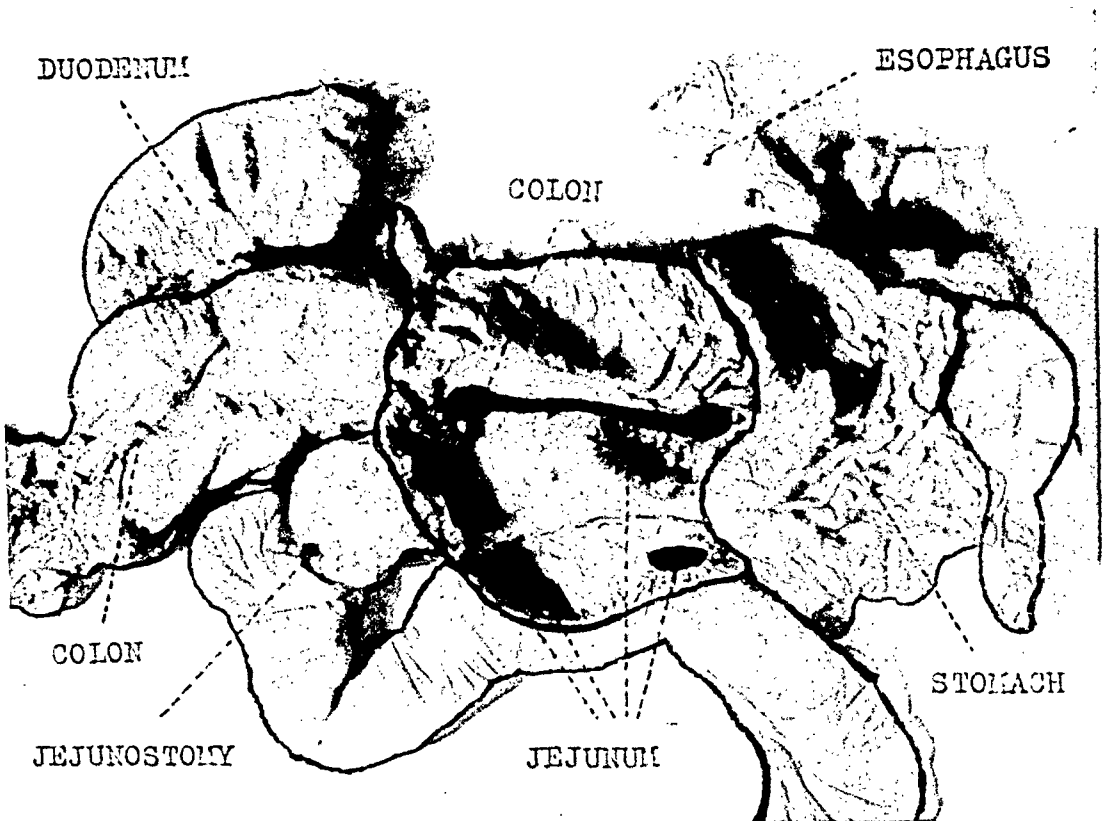


FIG. 1.—Photograph of the stomach and a portion of the jejunum and transverse colon showing an ulcerative communication between these organs.

very few moments after the injection of the meal, the entire parajejunal field becomes obscured with multiple coils of filled ileum, and from then on it becomes almost impossible to follow the process of physiology, on account of the shadow complexity."

Examination of the blood showed the following: Hæmoglobin 65 per cent.; red blood-cells 3,500,000; white blood-cells 13,200; polymorphonuclear leucocytes 82 per cent.; lymphocytes 18 per cent. The blood Wassermann was negative. The stools were thin, watery, and ochre colored. The guaiac reaction was ++. There was no mucus. The temperature during the entire stay in the hospital ranged between 98.6° F. and 100° until the time of death, when it rose to 102° F. The pulse ranged from 90 to 100.

During the stay in the hospital the patient complained of pain which was severe enough to require codeine. He was quite hysterical and at times sterile hypodermics of water seemed to relieve the pain. Two days before death the temperature dropped to 97° F. This was accomplished by extreme diarrhœa. The patient collapsed the night before death and was revived only slightly by caffeine and hypodermoclyses of 5 per cent. glucose solution. He remained in shock for about twenty-four hours and died

twenty-three days after admission. Abstract from the *Autopsy Protocol*: In the upper abdomen there are two old surgical scars, one 18 cm. long, the other 15 cm. long, both situated slightly to the right of the midline. There is a third healed surgical incision to the left of the midline, 4 cm. long. This is slightly above the level of the umbilicus.

On opening the abdomen the peritoneum is smooth, white, and glistening. The stomach, transverse colon, and first portion of the jejunum are adherent to the anterior abdominal wall by old fibrous bands. The intestines are collapsed and contain only a small amount of fecal material. The distal half of the stomach, pylorus and appendix are missing. At the point of resection of the stomach there is a spherical cavity bounded behind by the anterior surface of the third part of the duodenum, and having the front wall made up of the peritoneum of the anterior abdominal wall to which it is bound by fresh fibrinous adhesions. This deficiency in the anterior wall is about 4 cm. in diameter. The whole cavity is about 8 cm. in diameter. Opening into it from above is the stomach. An ulcerative process has involved the transverse colon which is connected with the cloaca by two stomata. Below these are two openings, one for the proximal portion of the jejunum, and a separate one for the distal end. At the most dependent portion the ulceration has involved an adherent loop of the jejunum in two places so as to form openings into the general cloaca. Just proximal to these openings is the point of the old jejunostomy which is identified by a fibrous band which fixes it to the anterior abdominal wall. There is no evidence of peritonitis.

Microscopic examination of the borders of the ulcer show only chronic inflammatory tissue, and no evidence of carcinoma.

*Summary.*—The patient was a man aged forty-six, who was first operated upon three years ago for duodenal ulcer. The operation was gastro-enterostomy, cholecystostomy, and appendectomy. One year later the gastro-enterostomy was undone and a jejunostomy was performed for a recurrent marginal ulcer. Two years later, or two months prior to the last admission, for reasons unknown, a partial gastrectomy and pylorectomy were done with a gastro-jejunostomy of the Polya type and an entero-anastomosis. The patient made an uneventful recovery and was discharged improved.

An attack of acute pain in the left upper quadrant of the abdomen brought the patient to St. Luke's Hospital for the first time. A tentative diagnosis of a recurrent marginal ulcer was made. There were no immediate surgical indications, and the patient was in too poor condition for elective surgery. While still being observed and studied in the hospital, the patient went into sudden shock and died about twenty-four hours later. The clinical diagnosis was internal hemorrhage, but this could not be demonstrated at autopsy. The immediate cause of collapse and death was not found. None of the lesions of the abdomen could be implicated.

Autopsy revealed an ulcerative communication between the stomach, transverse colon, and jejunum. None of these stomata appeared fresh and from the pathological condition found it is not reasonable to believe that sudden perforation into one of these loops of intestine caused the collapse before death. The communication between the stomach and transverse colon was not suspected, either from clinical findings or from Röntgen examination. The exact mechanism by which enemata could be given without nausea, regurgitation, or other special symptoms referable to the stomach is hard to explain. History of this patient, as analyzed in retrospect, demonstrates unusual and early fatal post-operative complication of surgery for duodenal ulcer.

# SURGICAL INTERVENTION IN EXTRA-UTERINE PREGNANCY.\*

OBSERVATIONS IN THE TREATMENT OF 109 CASES AT THE  
PENNSYLVANIA HOSPITAL

BY HENRY P. BROWN, JR., M.D.  
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EXTRA-UTERINE pregnancy is a condition frequently encountered among patients admitted to a general hospital. In the present paper it is sought to record the experiences in dealing with this condition at the Pennsylvania Hospital where all of the gynæcological patients are treated as general surgical cases. The diagnoses were made and operations performed by the various chiefs and assistants connected with the surgical departments, thus possibly representing more truly the average results to be obtained in handling this group of patients than when they are assigned to a service limited to gynæcology.

For the privilege of reporting this series, I am indebted to Doctors Gibbon, Mitchell and the former chiefs to whose services the cases were admitted.

During the period from 1918 to September, 1927, there were 109 cases of ectopic pregnancy admitted to the Pennsylvania Hospital, and while we fully realize that this is a very small number in comparison with some of the recorded series, it seemed worth while to compare our results with those of others.

The recent literature contains numerous articles dealing with the etiology and pathology of ectopic pregnancy, and it is not our intention to dwell at any length on these topics in this paper. Those interested in this aspect of the subject are referred to an article by M. R. Robinson<sup>1</sup> for an excellent description and discussion of its etiology and pathology. He states that the condition is due more to a functional disturbance of the tube, rather than to an inflammatory and mechanical condition of the tube itself, and presents gross and microscopic evidence to bear out this statement.

As has been shown by numerous authors, the cause of rupture and hemorrhage, the conditions from a general surgical viewpoint which are chiefly responsible for the symptoms, are dependent not only on the distention of the tube by the growing embryo, but also on the degree of penetration of its walls and blood-vessels by the fetal elements.

In our series we found that the combination of vaginal bleeding and abdominal pain was the condition most frequently causing the patient to seek relief (fifty-five per cent.) while lower abdominal pain without bleeding,

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\* Read before the Philadelphia Academy of Surgery, December 5, 1927.

occasionally accompanied by nausea or vomiting, was present in thirty-six per cent. of the cases. In three instances the patients merely complained of vaginal bleeding, no history of pain being elicited.

The question of whether bleeding from the uterus indicates a living or dead embryo is rather an academic one and we leave it to those better qualified than the writer to pass judgment, sufficient to say that among eminent authorities it is still a matter of controversy.

Only once did a patient complain of pain in the chest and abdomen—the so-called shoulder pain, supposedly due to sub-diaphragmatic irritation by the free blood in the abdominal cavity.

Eleven patients (ten per cent.) presented the typical picture of an acute ruptured ectopic pregnancy—menstrual history—sudden severe abdominal pain—fainting—anemia—low blood-pressure—vaginal bleeding, etc. Graf-fagnino,<sup>2</sup> in recording one hundred and eighty-six cases, states that fourteen and one-half per cent. gave a history of shock.

We do not place too much reliance on the patient's menstrual history, for where this was ascertained, thirty-eight per cent. stated that they had not missed a period; fifty-one per cent. missed one or more periods; in six cases it was irregular, and four women developed an ectopic while nursing their last children.

The interval between the last pregnancy and ectopic conception varied widely, thus, one woman, the mother of two children, stated that while two months' pregnant she miscarried one month previous to her admission to the hospital, her present symptoms having been of two weeks' duration. Another, the mother of three, was certain that she had miscarried forty days previous, her present symptoms also being of two weeks' duration. Eight cases had been pregnant less than one year previous to their admission and the vast majority had of course been pregnant one or more years previous to their present condition. Twenty-five per cent. of the patients had never been pregnant before; five of them had only had miscarriages; twenty-one per cent. had one child, most of the women being para, with or without abortions. One woman, an Italian, had to her credit five living children, ten who died in infancy and five or six miscarriages.

In four instances the patients were undergoing the second operation for ectopic, and only one other in the series had been previously operated upon—a salpingectomy in a colored woman.

At operation, or from the history, salpingitis was noted as having been present in ten per cent. of the cases, absent in eighty-three per cent., and no notation made in the remainder. This is somewhat in accord with the statement by Dr. Emily Barringer in discussing the paper by Robinson, that in thirteen hundred cases of gonorrhœa she did not see one case of ectopic while in the same series there occurred seventy-one cases of intra-uterine pregnancy.

The factor of a high leucocyte count, as pointed out by various writers, was not observed frequently enough to be of diagnostic value, for in only eleven cases where such an observation was made, was it over fifteen thou-

## SURGICAL INTERVENTION IN EXTRA-UTERINE PREGNANCY

sand. This may possibly be due to the fact that many of the cases in our series did not present themselves till the ectopic pregnancy had existed for some time.

In not a single instance was the recorded temperature on admission above 101° F.

As the onset of symptoms of an extra-uterine pregnancy is often insidious, depending largely on the degree and rapidity of rupture of the tube or embryonic sac, so, the interval between the onset of symptoms and the patient's admission to the hospital varied widely, thus seventeen per cent. were admitted within twenty-four hours of the onset—twenty-two per cent. between one and two weeks and twenty-four per cent. one or more months after noticing symptoms.

There seems to be quite a difference of opinion as to the most favorable time to operate upon a case of actively bleeding ectopic, some authorities (Polak<sup>6</sup>) advising delay until the patient has reacted from shock and hemorrhage, on the theory that when the patient has improved, she is in better condition to withstand surgical measures. Others advise exploration as soon as possible, giving blood transfusion or saline infusion (we prefer glucose and insulin, rather than saline) as indicated. We feel that the risk of delay in the hope that the bleeding will stop, is greater than when the abdomen is opened and the bleeding checked under direct supervision, thus, in sixty instances (fifty-five per cent.) operation was done within twenty-four hours of the patient's admission. In patients showing evidence of active bleeding, we do not give transfusion or infusion and delay operation in the hope that the patient will react, as Polak states is done by some general surgeons.

In cases where a differential diagnosis was not made upon the patient's arrival, the period between admission and operation obviously varies, upon ten occasions operation being done upon the second day, varying in frequency up to a week, a surgical emergency of course not being present in this group. Twice, from one to two weeks intervened before a diagnosis was made and operation performed, and twelve times, more than two weeks elapsed before the patient's abdomen was opened.

The question of differential diagnosis between ectopic pregnancy and conditions simulating it is not within the scope of this paper, sufficient to say that where operation revealed an ectopic pregnancy, a correct pre-operative diagnosis had been made in sixty-two per cent. of the cases. This does not take into account those instances in which exploration revealed that the pre-operative diagnosis of extra-uterine was incorrect. Most of our diagnostic errors were due to the condition being thought one of salpingitis, with or without involvement of the ovary—nineteen cases. (During the period covered by this paper there were admitted to the hospital 1337 cases listed as salpingitis, with or without involvement of the ovary.) Next on the list was appendicitis, five cases—then intra-uterine abortion with four, some of which were self-induced—then fibroids, four—pelvic abscess, three, and ovarian cyst, one, in the above order of frequency. In several cases, five times—

the error was made in thinking that various combinations of the above conditions were present. One case, a colored woman of twenty-eight with a plus four Wassermann, was kept under observation in the hospital for thirty days in the belief that she had a pelvic abscess, and when vaginal puncture was done, bloody fluid was revealed. When her abdomen was opened later on, a glistening tense mass was seen in the broad ligament having the appearance of a cyst. Upon opening this, it was found to be a pregnancy in the broad ligament, about three months, and the tube was removed and a pack inserted. She had rather a stormy convalescence but ultimately recovered. Another colored woman of thirty-four, with a large uterine fibroid and a dead abdominal foetus of about three and one-half months, was observed for thirty days before exploration was done.

Other cases could be cited demonstrating the difficulty in arriving at a correct diagnosis, but the point we wish to emphasize is that where the picture is not that of a surgical emergency, we have not seen any harm result from postponing operation in an attempt to arrive at a correct diagnosis. Conversely, where the condition is one of urgency, we do not delay exploration till a correct differential diagnosis is made. In this class, five abdomens were opened in the belief that the patient was suffering from acute appendicitis, and in one instance an acute appendix accompanied a right cornual pregnancy.

It is of interest to note that one patient referred her pain to the left side, and it was found that the ectopic was in the right tube.

In the present series, the right side was involved in fifty-eight per cent., and the left in thirty-eight per cent. of the cases, the resident failing to mention this point in the remainder.

The tube alone was removed in eighty-one per cent. and the tube and ovary in fifteen per cent. of the cases. Twice it was thought advisable to remove both tubes, and in one ovarian pregnancy, only the ovary was removed.

The question of whether transfusion or infusion is necessary in a woman who has lost a great deal of blood from a ruptured ectopic, was of considerable interest to us. In a few of the earlier cases an attempt was made to remove as much as possible of the extravasated blood, but in seventy-four per cent. of the cases this was not done, an attempt being made to leave as much of his blood in the abdomen as possible, this being, we believe, the procedure in most of the clinics to-day. Thirteen times it was thought advisable to perform auto-transfusion, using sodium citrate or normal saline solution as the vehicle for the blood, and in a similar number, one or more intravenous infusions of saline were given.

In no instance is it recorded that a post-operative reaction occurred which was attributed to this procedure.

Six of the thirteen patients receiving the saline infusion died, and in no instance was a death recorded among those receiving a blood transfusion.

This statement is not to be interpreted as indicating that the fatal outcome



## SURGICAL INTERVENTION IN EXTRA-UTERINE PREGNANCY

was associated with the fact that an infusion had been given, but rather that the patient's condition was so desperate that it was thought infusion advisable.

In the series of one hundred and ten operations—one patient had a second ectopic removed by us—there were seven deaths—a mortality of six and three-tenths per cent., which is rather high—twelve and three-tenths in Graffagnino's series<sup>2</sup>; four and thirty-nine hundredths for Wynne<sup>3</sup>—eight per cent. at Cooke County,<sup>4</sup> and less than one per cent. at the Women's.<sup>5</sup>

A very obese woman of forty-one, with symptoms for a week preceding her admission, was operated upon within a few hours of her arrival. A ruptured right tube was removed—her abdomen contained a great deal of free blood and she was given one thousand c.c. of saline infusion while on the table. Two days later her blood sugar went to two hundred and seventeen mg. per 100 c.c. She was given five hundred c.c. of whole blood and a similar amount of saline, and felt greatly benefited. She showed a marked nephritis, and died suddenly the same day.

A twenty-nine-year-old white girl was unconscious and almost pulseless when brought to the hospital, her tube having apparently ruptured only a few hours previous. A ruptured right tube was removed, the abdomen was found filled with blood—she was given normal saline intravenously but failed to react, and died three hours later.

A white girl of thirty-two, whose right tube had been removed four years previously—pathology unknown—had been having symptoms for two weeks previous to admission, and was taken acutely ill the day she came to us. A ruptured left tube was removed—she was given hypodermoclysis, the notes stating that both antecubital areas were incised without success in an attempt to give a transfusion—she reacted quietly and died three days later from a recurrence of hemorrhage. Post-mortem not obtained.

The fourth case was a woman of thirty-five, who at operation within five hours of the onset of symptoms typical of a ruptured ectopic, showed a ruptured right tube, which was removed. She was given five hundred c.c. of saline intravenously and died three hours later without reacting.

Sarah S., a white woman of twenty-two, with symptoms of four days' duration before admission, had a right cornual rupture, with profuse hemorrhage. A litre of saline was placed in the abdomen before closing and five hundred c.c. was given intravenously. Two days later she was given another five hundred c.c. of saline infusion, and died on the third post-operative day. The abdomen was reopened, no fresh blood was seen and the ligature had not slipped.

In a white woman of thirty-six with a ruptured right tube, and free hemorrhage, five hundred c.c. of saline having been given intravenously at the time of operation and her post-operative reaction having been fairly good, the resident's notes merely state that she died next day.

Ella D., a colored woman of twenty-nine—the earliest case of the series—was the one case ending fatally, in which a correct diagnosis was not made. She had not missed any periods since the birth of her third child. Pain in the lower abdomen and vomiting had been present for three weeks before she sought relief in the hospital, and on admission her T.P.R. were 103-156-48 with 10,000 leucocytes. She was a thin, poorly nourished restless negress, with moist skin, pale mucosa, jaundiced conjunctivæ and a distended abdomen which was very prominent in the lower half, and the liver was palpable four fingers' breadth below the costal margin. She had great general abdominal tenderness which was well marked in the lower left quadrant, with rather generalized rigidity across the lower abdomen. It was thought that dulness was detected in both flanks. Vaginal examination revealed a slight amount of fetid discharge—the cervix was soft and admitted one finger, the lower uterine segment was soft—the uterus somewhat enlarged and not freely movable. A vague indefinite resistance was felt posterior to the uterus, in the midline, extending more to the left than to the right. A consultation

was held with the chief of the opposite service who advised exploratory operation. The opinion of the majority was that the condition was one of salpingitis, with endometritis, and operation was deferred. She was given an intra-uterine douche—we have long since discarded this procedure—and promptly went into a state of collapse. Next day her jaundice was much deeper, she had two chills—temperature 104; hæmoglobin 78 per cent.; leucocytes 8400; she grew much weaker and died two days after admission. Post-mortem showed a ruptured left extra-uterine pregnancy—free bloody pus in the pelvis—general peritonitis—hypertrophy of the liver—abscess of the spleen and septic endometritis.

As was mentioned at the outset of this paper, this series is too small to warrant drawing any conclusions of value and we fully realize that we have not presented any new thought. From a review of the cases, however, a few factors have been impressed upon us, among which are—the difficulty in arriving at a correct diagnosis in the atypical cases—the fact that not much reliance can be placed in the patient's menstrual history nor the fact that she has not had previous pregnancies—that when the symptoms are vague enough to create a doubt as to the diagnosis, *i.e.*, an acute surgical emergency not being present, there is no harm in a reasonable delay in order, if possible to arrive at a correct diagnosis—that where it seems indicated an auto-transfusion does no harm, although it must be remembered that many patients with extensive loss of blood recover quite well without this procedure—in those cases presenting symptoms of active bleeding immediate operation should be done without waiting for the patient to react from shock, and that no matter how extensive the intra-abdominal hemorrhage or degree of shock may be, there is always a chance for the patient to recover, as was noted many times.

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# FRENCH-HEEL FRACTURES OF THE TARSAI SCAPHOID

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IN REPORTING the above condition the author is unaware of a similar entity being fully described in the literature and wishes to present an original contribution upon a condition that is far from uncommon.

Ross and Stewart in a study of sprain-fracture,<sup>1</sup> and in a further study of sprain-fracture as an essential to

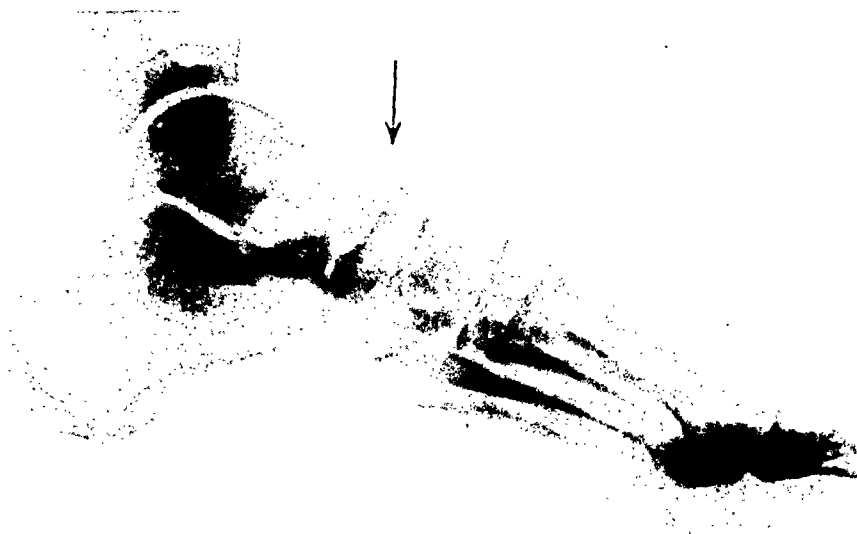


FIG. 1a.—Sprain fracture of the tarsal scaphoid, the size of a pea.

the occurrence of dislocation,<sup>2</sup> have performed the best work on the experimental production of this condition in dogs. They likewise note 145 cases of various sprain-fractures as found in reviewing the X-ray films



FIG. 1b.—Fragment half the size of a cherry, fractured from the tarsal scaphoid.

of the Lanke-nau Hospital. Forty-six of these occurred around the ankle-joint. Experimenting upon anæsthe-tized dogs in the production of sprain-frac-tures of differ-ent joints, they were definitely

able in seven cases to demonstrate sprain-fractures of the astragalus, os calcis, cuboid, scaphoid, cuneiforms and metatarsals.

Three cases reported by Cook<sup>3</sup> were comminuted fractures of the body

rather than sprain-fractures of the superior surface of the scaphoid. Horowitz's cases were of the tubercle.<sup>4</sup>

It is generally recognized that fractures and severe sprains about the ankle-joint are besides disabling, frequently difficult to treat. Sprain-

fractures and severe sprains of the ankle often give the attending physician more annoyance and the patient more pain than do complete fractures. This is partly due to the attitude of the patient who, learning that an X-ray is negative for gross fractures feels that he may (and does) use the part as he desires—the overuse and insufficient immobilization resulting in chronically relaxed ligaments or tendons ununited to their bony attachments. Mostly it is due to a failure to diagnose accurately and treat properly.

The author has had occasion to treat a large number of traumatic ankles and because of the routine of X-raying all injuries to bones and joints, has observed a condition which is a definite clinical entity. It is probably far more common than is suspected and will be seen most often by those who, more than others, uniformly X-ray all traumatic bone and joint conditions. Manges points out that sprain-fractures are far more common than has heretofore been appreciated.<sup>5</sup>

Anatomically it is a sprain-fracture of the superior surface of the tarsal scaphoid affecting the anterior capsular ligament of the ankle-joint, the superior astragalo-scaphoid ligament and the dorsal scapho-cuneiform ligament.

Occasionally a small fragment of bone is detached from the anterior portion of the superior surface of the astragalus or the posterior portion of the superior aspect of the cuneiforms. The size of the bony fragment varies from that of a pea to half the size of a cherry. (Fig. 1.)



FIG. 2.—Illustrating high heeled evening slippers without anterior support to the ankle, strap pumps, and moderate sized heel, lacing oxfords.



FIG. 3.—Röntgenogram of foot with low heeled shoes. Note the horizontal plane of foot, the close mortising of tarsal bones, lacing support and relaxation of anterior portion of ankle-joint.

## FRENCH-HEEL FRACTURES OF THE TARSAI SCAPHOID

*Etiology.*—The cause, in the majority of cases, has been due to hyperextension (plantar flexion) of the foot upon the ankle-joint accompanied as a rule by some inversion or eversion. *Eighty per cent. have occurred in females wearing high-heeled open slippers or pumps, hence the name.* Thereby hangs the cause and treatment.

There are sundry varieties of footwear for the female sex ranging from so-called sensible, low-heeled, lacing Oxfords (Fig. 2) to moderate or high-heeled strap-pumps with a single strap across the tarsus which supports the tarsal joints anteriorly, to high-heeled open pumps and other extremely high and spiked-heel evening slippers without any anterior supporting straps, being completely open in front. The latter types when used occasionally cause no particularly permanent pathology. When used daily, rather than on occasion, the continually maintained hyperextension of the foot is bound



FIG. 4.—Röntgenogram of foot in high heel strap-pump. Observe the extended plane, widened tarsal joint spaces, and the lack of anterior support resulting in chronic sprain of the anterior ligaments.



FIG. 5.—Anterior "stirrup" adhesive straps to prevent extension of foot and maintain support while fibrous union of ligaments occurs.

to result in a tense and chronically weakened condition of the anterior ligaments supporting the ankle-joint. The author has X-rayed the ankle-joint in various types of footwear and noted the widened anterior tarsal joint spaces occurring with high-heeled shoes in comparison to the normal anatomical joint positions in low-heeled shoes. (Figs. 3 and 4.)

A sudden twist of the ankle or fall upon stairs (66 per cent.) with the foot already in a hyperextended position and weakened state results in a detachment of the bony tendinous or ligamentous attachment. A sprain-fracture is the result.

*Treatment.*—To secure bony union of the fragment, to relax the stretched and weakened ligaments and secure a strong and healthy foot again, it is necessary at once to prevent the foot from being hyperextended or extended.

It has been the author's experience in the fifteen cases outlined to achieve this by having the patient discard high-heeled slippers for several months and wear low-heeled Oxfords with anterior adhesive straps. Extension itself, for two or three weeks, is prevented by slightly flexing the foot and securing it in this position by anterior "stirrup" adhesive straps. (Fig. 5.) These are approximately two inches wide and eighteen to twenty-four inches long, secured to the lateral surface of the lower one-fourth of the leg, passed laterally over the ankle, across and under the plantar aspect of the tarsal region and up to a point on the leg opposite the start. Several straps overlapping each other are required to maintain



FIG. 6.—Sprain-fracture of the superior surfaces of the tarsal scaphoid and cuneiform.

the foot in slight flexion. The straps may likewise be so applied as to cause eversion or inversion of the foot if and when desired.<sup>6</sup> A figure-of-eight bandage to the foot and ankle may be used in addition; alone, the bandage is practically of no value. The straps should be examined and changed, or reinforced if necessary, every five days for three weeks or possibly more, depending upon the individual case. It is generally advisable to have the patient remain at home for the first few days. After this, if immobilization that permits the foot from being extended has been secured, permitting the patient to walk without pain but with some constriction of movement, her usual activities may be resumed. Charlestoneing, athletics, etc., naturally should be avoided.

After three weeks of the "stirrup" straps, an elastic ankle support can be worn to advantage in mild cases, and should be worn, of necessity, in all severe cases.

*Clinical Notes.*—In the last three years the author has seen 20 cases of tarsal sprain-fractures, fifteen with sufficient recorded data to be reported. Of the 15 cases, 12 (80 per cent.) occurred in females, 3 or 20 per cent. in males. The average age was 26.6 years, the youngest was 17 years of age,

## FRENCH-HEEL FRACTURES OF THE TARSAL SCAPHOID

and the oldest 39 years. Seven were reported by the röntgenologist, eight (over 50 per cent.) were not. Falls on stairs or steps caused 10 (66.6 per cent.), twists 2 (13 per cent.), falls from a height 2 (13 per cent.), and direct trauma 1, or 6 per cent.

The tarsal scaphoid alone was affected in 9 (60 per cent.) of the reported cases and in all five unreported cases. The scaphoid and astragalus together were affected in one case, the scaphoid and cuneiform in two (Fig. 6), the astragalus (Fig. 7) in two, and the astragalus with a small chip from the anterior surface of the tibia in one case. It will be seen from these cases that the tarsal scaphoid, alone or with other bones, was affected in 80 per cent. of the injuries.

Ecchymosis on the lateral or anterior aspect of the ankle-joint was present



FIG. 7.—Sprain-fracture of the anterior superior surface of the astragalus.

in 75 per cent., once it extended dorsally toward the toes. Swelling was present in all, generally anterior or lateral to the ankle-joint. Pain on pressure over the tarsal bones mentioned, and when the foot was placed in plantar flexion occurred in all cases. The opposite position, maintained, relieved it. This has been termed by the author as "scaphoid pain".

Of the fifteen cases five were seen originally, and lost an average of nine days from work. Ten cases were referred or seen in clinic after having been diagnosed and treated elsewhere with bandages, etc., as a sprained ankle. The average time lost in these cases was twenty-four days. One had been given a plaster case needlessly and was incapacitated for forty-seven days.

Prolonged immobilization is unnecessary as bony union of the detached fragment rarely results, it being too small to form any callus. A firm fibrous union occurs, reuniting the ligament to the tarsal bone to which it is attached.

SUMMARY

(1) A definite sprain-fracture of the tarsal bones, particularly the scaphoid, is noted.

(2) It occurs most often in females wearing high-heeled shoes after falling on stairs, inverting and hyperextending the foot.

(3) It is best treated by flexion of the foot maintained by anterior "stirrup" adhesive straps; the use of low-heeled Oxfords temporarily, and an ankle support if necessary.

(4) The majority of cases are diagnosed as sprains with a consequent lengthened disability for the patient.

(5) X-ray films should be examined personally when possible.

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- <sup>4</sup> Horowitz, A. E.: *ANNALS OF SURGERY*, vol. lviii, 1913.
- <sup>5</sup> Manges, W. F.: *ANNALS OF SURGERY*, p. 126, January, 1912.
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# TRANSACTIONS

## OF THE

# PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held December 5, 1927*

The President, DR. CHARLES F. MITCHELL, in the Chair

### HÆMOPHILIA IN AN ADULT

DR. PAUL A. LOEFFLAD, by invitation, presented a man, aged forty-four, from the Surgical Service of Dr. Alfred C. Wood at the Philadelphia General Hospital, who was admitted November 7, 1926, complaining of pain and swelling of the right hand. Two weeks before admission he had struck the little finger of the right hand, resulting in an infection which involved the hand and forearm. Hot applications of magnesium sulphate were applied and the infection subsided without any incision, which was delayed due to his hemorrhagic disease. Physical examination revealed several lacerations of the scalp resulting from previous injuries. There were many missing teeth and the remaining ones were carious. Examination was otherwise negative, except for a small mass in the left inguinal region. The external abdominal ring on the left side admitted the examining finger and an impulse was felt upon straining. A blood count revealed: hæmoglobin, 80 per cent.; red corpuscles, 3,500,000; white blood corpuscles, 10,000. A differential count: polymorphonuclears, 59; lymphocytes, 29; transitionals, 4; eosinophiles, 8 per hundred cells. Coagulation time, 12 minutes; bleeding, 2 minutes; platelet count, 30,000. Blood sugar, 118; urea, 14; uric acid, 3.4 per hundred mg. of blood. Wassermann negative. For one week before operation Ceanothyn in four dram doses was administered by mouth every 4 hours. After four days the coagulation time had fallen from 12 to 8½ minutes. On the day previous to operation 500 c.c. of citrated blood was given intra-abdominally. The coagulation time on morning of operation was 6 minutes and the bleeding time 2 minutes. December 15, the left direct hernia was operated upon following the Bassini technic under open-drop ether anæsthesia. On the day following the operation 500 c.c. of citrated blood were again given. The patient developed a large hæmatocele post-operatively, but otherwise there was no bleeding or other complication. He was discharged January 26, at which time the coagulation time was 7 minutes and the bleeding time 2 minutes.

The patient was readmitted October 14, 1927, with a large bleeding wound of the scalp and pain in both knees. While sleeping in a cot he had fallen to the floor, striking his forehead and both knees. Examination revealed a lacerated wound of the right side of the forehead and swelling, pain and limited motion of both legs. Considerable difficulty was encountered in attempting to arrest the bleeding. Parathormone, 1 c.c. intramuscularly, was administered daily, which lessened the amount of oozing. Tight bandages were applied to the knee-joints in preference to tapping for fear of more hemorrhage. After a week of oozing from the scalp wound, the bleeding subsided. There was considerable limitation of motion in both knees upon discharge. X-ray of both knees revealed no changes in the bony structures. The coagulation time on admission was 12 minutes and on discharge 10.

At the present time there is full motion of the left leg with some limitation of flexion and extension of the right leg. There is also a small mass about the size of a walnut in the left scrotal sac, just above the testicle, which is probably an organized blood clot, the remains of the hæmatocele. There is no evidence of recurrence of the hernia. The family history of this patient shows that one brother died following a nephrectomy. He was also a bleeder. A sister has one son now under treatment for hæmophilia while another sister has lost a son following a circumcision. The patient's own history is that he has been admitted ten times to the Philadelphia General Hospital suffering either from lacerations or hæmatomata. Twice he was admitted following the extraction of teeth with resulting uncontrollable hemorrhage. Another time he was admitted with an incarcerated hernia. At the time of admission there was no evidence of obstruction or gangrene of the incarcerated loop, so that it was deemed advisable, in view of the hemorrhagic disease, not to interfere surgically. At present he has still a slight oozing from his scalp wound whenever the dressings are changed.

#### UNDESCENDED TESTICLE—TOREK OPERATION

DR. K. P. A. TAYLOR, by invitation, presented a patient, a negro boy, aged five, from the Surgical Service of Dr. A. C. Wood, at the Philadelphia General Hospital, with an undescended testicle. The first stage of an operation for its correction had been done six weeks before. The procedure used was that devised by Torek and later used by Willy Meyer and others and described by Meyer in *Surgery, Gynecology and Obstetrics*, January, 1927. The operation differs in no way from the Bevan operation, except in so far as the measures undertaken for the control of contraction of the cord and testicle post-operatively. The usual hernia incision is made with dissection of the vas and cord, with complete separation of the blood-vessels of the cord from the surrounding fascia; by way of retention of the testicle, an oblique incision is made in the undeveloped half of the scrotum and another corresponding incision through the skin of the thigh, exposing the fascia lata. The posterior margins of these two incisions are united by interrupted sutures. The anterior margins of the wound are closed so that the testicle is covered in a pocket and secured to the fascia lata. The testicle appears to be in the scrotum. Special precautions were taken to avoid soiling; an indwelling catheter being used and the wounds sealed with collodion. Moskowicz reported the end results of 405 cases of undescended testicle and expressed disappointment with the end results secured. The operations were conducted according to the principle of Bevan; in some cases, the vessels of the cord, with the exception of the artery accompanying the vas itself, were dissected in order to permit the necessary lengthening of the cord. Coley in a paper two years ago expressed disappointment with the end results of the operation. The operation under discussion devised by Torek has been employed in 64 cases reported from the Lenox Hill Hospital in New York with satisfactory results. The speaker regarded Doctor Meyer's conclusions as ambiguous, in that he states that all the patients were satisfied with the results obtained and yet he admits that only 35 cases were followed to a logical conclusion. The results in these cases, however, were satisfactory. This is a higher percentage than usual. Meyer thinks that the second stage of the operation should be undertaken five or six months after the first. It is his opinion that from three to five months are necessary to insure the cord against final retraction.

## UNDESCENDED TESTICLE—TOREK OPERATION

DR. JOHN H. JORSON remarked there is no reason to be dissatisfied with the results of the Bevan operation in the majority of cases. The speaker has been following the development of this operation for a number of years and has been amused by the change of ground taken by certain men as to the finer details of the operation. He considered it a mistake to divide the spermatic artery and vessels of the pampiniform plexus before puberty, when everything would seem to indicate the necessity for conserving the blood supply. One very necessary step consists in lengthening the cord by anatomical dissection and severing of all the fasciæ included in it. Davidson advised following the vas deferens into the extraperitoneal space, and abolishing its curve over the peritoneum. A still more useful development was the contribution whereby the spermatic artery was followed up and freed behind the peritoneum, its shortness being the main obstacle to bringing the testicle down. There have been very amusing suggestions for correction by traction, such as a suture through the testicle and scrotum with a rubber band attached to it and attaching the rubber band to a child's toe so that constant traction would correct the condition. Any attempts to retain the testicle in position by suturing it to the bottom of the scrotum are futile, unless the cord has been properly lengthened. In only a few cases has it been found impossible to bring the testicle well below the spine of the pubes. If it is gotten there and if the external ring is made small enough, it will stay outside the canal.

DR. A. P. C. ASHHURST remarked that no one has mentioned Ombredanne's operation. This procedure is popular in France but is not followed much in this country. It is based on the principle that if the mountain will not go to Mohammed, then Mohammed must go to the mountain. It consists of an inguinal incision and dissection, as usual, and then the making of an incision in the opposite side of the scrotum, and drawing the testicle through this buttonhole to the other side of the scrotum. The testicle is fixed to the septum, and the opening in the septum is reduced in size by sutures, so that the testicle will be unable to draw back again. If the testicle will not reach the scrotum, the scrotal septum is pulled up to the testicle at the external ring; but gradually the testicle is drawn down during convalescence. If the condition is bilateral, then the right testicle is placed in the left scrotum and the left testicle in the right scrotum. The speaker never had much success with the ordinary operation, in making the testicle stay down where it belonged, but since using Ombredanne's method he has found the testicle stays well down in the scrotum. Doctor Ashhurst has done the double operation upon one patient only, but the testicles seem to be staying down nicely. The patient and his parents are entirely satisfied with the result. It is a simpler operation than the method described by Doctor Taylor, being done at one sitting; and as far as he knows the procedure has been found to accomplish the desired result.

DR. K. P. A. TAYLOR remarked that Doctor Meyer in reporting his cases pointed out that the operation was not to be considered one of traction.

Keetly had described a similar incision several years before, using a longitudinal instead of an oblique incision and suturing the testicle to the fascia lata under tension. In the present instance, emphasis was placed upon the importance of very high dissection of the cord, complete separation of the vas from the spermatic vessels and pursuit of the vas as close to its termination as possible and following of the vessels of the cord to at least two and one-half or three inches retroperitoneally—as far as could safely be accomplished. This is not in any sense an attempt to lengthen the cord by traction; it is simply an attempt to hold the testicle in place until such time as the structures become accustomed to their new position.

## DEFORMITIES OF THE MANDIBLE

DR. ROBERT H. IVY presented two patients with deformities of the mandible.

CASE I.—A boy, fourteen, who when eleven months old fell out of a baby coach, after which it was seen that he had bruises on the left side of



FIG. 1.—Profile view before operation showing retrusion of skin.



FIG. 2.—Deviation of chin to left.

the face. An abscess developed in the temporal region shortly after the accident, but no bone was exfoliated. As he has grown older his parents have noticed that his lower jaw has not grown straight.

Examination on November 30, 1926, showed with the mouth closed, a deviation of the chin to the left side, with a rounded appearance of the left side of the face and flattening of the right side. (Fig. 2.) The upper front teeth protruded far in advance of the lower, and the chin was markedly

retruded. (Fig. 1.) The patient could open the mouth to about the normal extent, indicating no lesion of the mandibular joint, but the whole lower jaw and teeth swung toward the left on opening. (Fig. 3.) The distance from the left mandibular condyle to the symphysis menti was about 2 cm. less than that from the right condyle to symphysis. The X-ray showed no evidence of a lesion of the condyle. The left ascending ramus appeared to be thicker and shorter than normal.

The appearance of the boy's face was typical of that seen in cases of unilateral ankylosis of the mandibular joint occurring in early childhood. The absence of ankylosis made probable a diagnosis of old fracture of the left ascending ramus somewhere below the joint with shortening and good union. This case bears out my observation that ankylosis is only to be feared in fractures involving the joint and head of the condyle, and that in fractures through the neck of the condyle and below, it is unnecessary to take any steps to avoid ankylosis, although with union, lateral deviation of the chin from shortening may occur.

The problem in this particular case was to lengthen the left side of the mandible bringing the chin to its normal position forward and medially, and by this at the same time to correct the malrelationship of the lower dental arch with the upper. This was accomplished by section of the



FIG. 3.—Deviation of jaw to left on opening mouth.

left side of the jaw, allowing the chin fragment to be drawn forward, and subsequent filling of the gap thus produced by means of a bone graft. The first molar teeth having been previously lost by caries, this edentulous region seemed to be the most favorable site for the section. Before the operation, wire arches were attached to the upper and lower teeth to provide for fixation in the corrected position. December 10, 1926, under ether anæsthesia, small skin incision was made at the left lower border of the mandible beneath the first molar

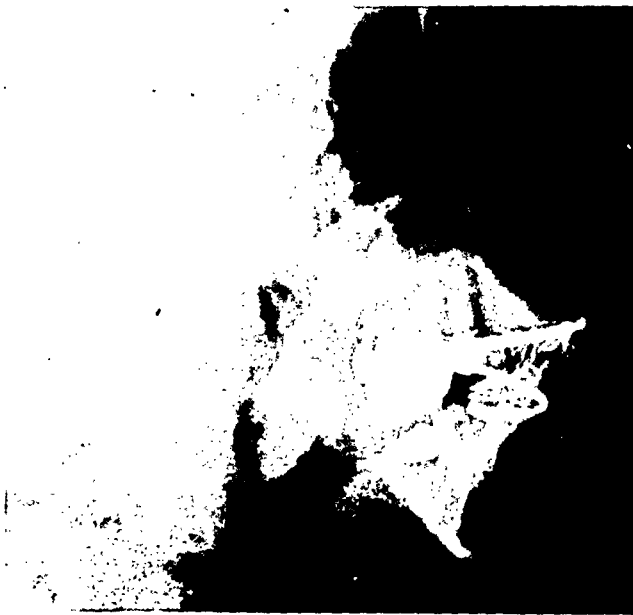


FIG. 4.—Radiograph showing gap in mandible after osteotomy.

region, and a Gigli saw was introduced on the lingual side of the bone until one end protruded into the mouth. By this saw the bone was divided vertically, thus permitting the chin to be pulled forward and to the median line,

bringing the teeth into approximately correct occlusion. The teeth were then fixed in occlusion by means of wires connecting the upper and lower arches. The external incision healed by primary union. After twelve weeks of fixation in this manner the mucous membrane had thoroughly healed over the site of the osteotomy and the X-ray showed a gap of 2 cm. in the mandible caused by drawing forward the chin. (Fig. 4.) March 11, 1927, under ether-oil colonic anaesthesia, the gap was exposed by an incision beneath the border of the jaw, the bone ends were freshened and three flexible strips of osteoperiosteal graft from the left tibia were laid between the fragments. The wound was closed without drainage and healed with no complications. (Fig.



FIG. 5.—Profile after operation. Chin has been drawn forward.



FIG. 6.—Chin restored to median lines.

7.) Union was found to be complete in 12 weeks and the wire fixation was removed from the teeth, which then maintained their proper relations. The chin stayed in its forward and median position (Figs. 5 and 6), and there was no interference with opening and closing of the mouth. There remained a flattening of the right side of the jaw, which was made more symmetrical by laying over its outer surface a strip of osteoperiosteal graft from the right tibia, on July 8, 1927. Examination at the present time shows great improvement in the appearance of the face and in the relationship of the teeth for mastication. Further correction of the malocclusion can be brought about by orthodontic means.

Particular attention to the correction of this type of deformity has been given by V. P. Blair and V. H. Kazanjian in this country, and by A. Limberg, Leningrad, A. Lindemann and C. Bruhn, Dusseldorf, and H. Pichler, Vienna.

CASE II.—A man, twenty-eight, July 20, 1924, met with a very serious automobile accident, sustaining comminuted fractures through the body of the mandible on both sides. Loss of bone by sequestration left ultimate healing with about 2.5 cm. loss of substance on each side. During the period

of healing, collapse of the symphysis was prevented by fixation of the upper and lower teeth with interdental splints. This part of the treatment was carried out by Dr. Joseph D. Eby, of New York. In August, 1925, he had a double iliac grafting operation in New York. The graft on the left side exfoliated, while that on the right underwent some absorption and did not bring about union.

On May 20, 1926, examination showed the symphysis portion of the mandible to be freely movable, with a gap in the left side of the body about 2.5 cm. long. On the right side the X-ray showed the partly absorbed remnant of an iliac graft without union to the mandibular fragments. Even though the lower teeth were held in relation to the upper by splints, some retrusion of the chin was visible externally owing to slight backward displacement and to atrophy of overlying soft tissues. Hollows in the soft tissues were also visible externally over the ascending ramus on each side.

May 21, 1926, under ether-oil colonic anaesthesia, through a skin incision beneath the lower border of the mandible on the left side, the gap in the bone was exposed, the ends of the bone fragments were freshened and a graft from the crest of the left ilium was laid in the defect, with its ends in good contact with the mandibular fragments, being attached to the latter by means of soft brass wire sutures. The wound was closed without drainage. On the right side, a similar incision was made and scar tissue over the remnants of the old iliac graft and the mandibular fragments was dissected out, exposing fresh bone surfaces. The partly atrophied graft was not removed. The fresh bone surfaces were then



FIG. 7.—Radiograph showing gap in bone filled by osteoperiosteal graft.

overlaid with three strips of osteoperiosteum from the right tibia, and the wound was closed in two layers without drainage. Doctor Eby's splints were left in position for three months, fixing the upper and lower teeth together. At the end of this time firm bony union was found on the right side. On the left side some motion was still present at the posterior end of the iliac graft and the latter was reënforced by a strip of osteoperiosteum from the left tibia, laid over it. After two more months of fixation by the interdental splints, the latter were removed and firm union on both sides was found. The function of mastication was quickly restored as motion was permitted. There still remained the retrusion of the chin and the hollows over the posterior portion of the mandible. In November, 1926, the prominence of the chin was restored by a piece of costal cartilage suitably shaped and inserted in contact with the anterior surface of the symphysis through an incision just beneath the point of the chin. Uncomplicated healing followed. February 25, 1927, the hollows over the ascending rami were plumped out by embedding strips of fascia lata from the left thigh into subcutaneous pockets.

The nature of this man's occupation (life insurance) demands a good personal appearance. Though perhaps physically able to gain a livelihood after union of the mandibular fragments, it was only after the cosmetic chin operation that his morale was sufficiently restored to enable him to return to his work with full confidence.

The case is somewhat unusual in that we were obliged to transplant tissue from four different sources.

### MASSIVE COLLAPSE OF THE RIGHT LUNG FOLLOWING NEPHRECTOMY FOR LEFT-SIDED HYDRONEPHROSIS

DR. LEON HERMAN reported the case history of a lad of seventeen years, who had an initial attack of left-sided renal colic three years ago. Since that time he has had six attacks, the last one June, 1927. He was admitted to the Pennsylvania Hospital, September 22, 1927. There has never been gross hæmaturia. A cystoscopic examination was made on the day of admission with the following findings:

The urethra is small, admitting only a Number 18 F. scope. The bladder is tolerant and of large capacity. There is a deformity of the trigon which in the absence of scarring is in all probability of congenital origin. The left urethral orifice is normal in appearance but is small and displaced upward and to the left. The right ureteral orifice is in the midline of the bladder. The vesical mucosa is normal throughout. The interureteric bar is greatly thickened and there is marked generalized trabeculation present. There is an extraordinary deformity of the outlet due to the intravesical invasion of the prostate gland. The cystoscopic appearance of the sphincteric margin is that of an aged man with marked benign hypertrophy of the prostate—there being a deep anterior cleft but no signs of median bar or lobe formation. The gland by rectum is small, soft and smooth. A Number 5 catheter met with an obstruction at the level of the left uretero-pelvic junction. This was easily overcome and the catheter entered a large hydronephrotic sac from which 160 c.c. of clear urine was aspirated but the sac was not emptied. This urine was normal and sterile. The differential functional studies showed a faint trace of the dye in sixteen minutes and less than five per cent. in one-half hour. The right kidney was normal and apparently supporting life unaided. Following this instrumentation which included the production of a pyelogram, the patient developed abdominal pain and distention, a large tender mass in the region of the left kidney, fever, leucocytosis and vomiting. The pyelogram had been made after injecting 75 c.c. of twenty-five per cent. sodium iodide solution, the strong solution having been used in the belief that it would diffuse through the contents of the sac and give a more detailed picture. September 26 a catheter was introduced into the left kidney and ten ounces of cloudy bloody fluid aspirated. This contained forty-five pus cells to the high power field and a non-hæmolytic staphylococcus was cultured from the fluid. The catheter was retained in the kidney for several days for drainage and the patient rapidly improved.

October 1, nephrectomy was performed under ether anæsthesia. The pre-operative diagnosis of hydronephrosis due to an anomalous vessel crossing the ureter was not confirmed, but the upper ureter crossed a band of fibrous tissue which in all probability contributed to the obstruction. The patient was cyanotic from the outset, and when the adherent kidney was freed from the discharge and opened during the procedure the condition of the patient became alarming. The operation was completed quickly and after stimulation with atropine and subcutaneous salt infusion he reacted. After being kept in the operating room for one hour after the conclusion of the operation, conditions were entirely satisfactory. The convalescence was uninterrupted until October 3, when the patient complained of pain in the right chest and dyspnœa. There was some cough with blood-tinged sputum and it was found that expansion of the right chest was very limited. The physical examination revealed consolidation of the right lung and hyperresonance of



the left one. The heart was displaced far to the right. X-ray examination confirmed the clinical diagnosis of massive collapse of the lung. The patient was treated expectantly; no bronchoscopic examinations or treatment being employed. Recovery was uneventful and the patient was discharged November 1. X-ray examination at that time showed the lung to be normally expanded.

DR. C. F. MITCHELL said that it is always a grave question in such cases whether or not to use the bronchoscope. It is a temptation to leave them alone in the hope that they will get well, but there is no doubt that they are benefited by bronchoscopic treatment and recover sooner if this sticky mucus is removed.

DR. D. B. PFEIFFER said that Sante, of St. Louis, recently reported that he had been successful in clearing up collapse of the lung by the simple expedient of rolling the patient onto the unaffected side and having him cough. In several cases reinflation of the collapsed lung occurred within a few minutes in very dramatic fashion. This is a simple measure, almost always practicable and is worthy of extended trial. It is noteworthy that the atelectasis in Doctor Herman's case occurred on the contralateral side from the lesion which seems to be the invariable rule in operations upon one kidney. The significance of this seems to lie in the fact that collapse occurs in the dependent lung; the operative and frequently the post-operative posture being the lateral one. Scott and Joelson, in the last issue of the *Archives of Surgery*, have reported a case in which massive collapse occurred in the same patient following successive operations for bilateral renal calculus. In each case collapse developed in the dependent lung. Whatever influence may be ascribed to nervous reflexes in the development of this curious condition, it is certain that the dependent position favors both venous and capillary congestion and bronchial occlusion by retained secretions. The reverse position, therefore, has much to recommend it in both prevention and cure.

#### OPERATIVE RELIEF OF EXTRA-UTERINE PREGNANCY

DR. HENRY P. BROWN, JR., read a paper with the above title, for which see page 581.

DR. JOHN M. FISHER said that very early in an ectopic pregnancy, as early as four weeks, blood can be found extravasated into Douglas' pouch; and when in doubt as to diagnosis an incision can be made in the posterior cornu, and if blood is found, it is a strong evidence of the existence of ectopic pregnancy. Another thing to which Doctor Brown did not call attention is the tenderness of the cervix which is found as a rule in cases of unruptured ectopic pregnancy. Quite frequently, we find such a condition present at the third or fourth week. Another feature is that pulsation of the uterine artery on the pregnant side is much more distinct than on the opposite side. Since accurate diagnosis of the location of rupture cannot be made, Doctor Fisher feels that the best thing in ruptured extra-uterine pregnancy is to do an immediate operation. Regarding the giving of blood transfusion or intravenous injections before operation, he thinks this is a mistake; if there

is a bleeding point in the abdomen, the vessels are filled the more the bleeding increases. If given at all, the best time is just before operation is begun and then by the time the surgeon gets into the abdomen, the transfusion will have been given without detriment to the patient. As to leaving blood in the abdomen following operation, this is quite the proper thing to do. It avoids unnecessary delay in getting the abdomen closed; the sterile blood is absorbable and aids in the patient's recovery.

## HARELIP AND CLEFT-PALATE

DR. WARREN B. DAVIS read a paper entitled "A Study of 425 Consecutive Harelip and Cleft-Palate Cases," for which see page 536.

Dr. R. H. IVY said that his experience with this work is limited as compared to the essayist, covering not more than a hundred cases. He can recall at least three colored children in his series, as compared to only one recorded by Doctor Davis. This is accounted for by the fact that most of his work has been done at the Polyclinic Hospital, where a large proportion of negroes are seen. Doctor Davis brought out an interesting observation bearing on heredity, which the speaker had not seen mentioned elsewhere, viz.: the large proportion of cases where collateral members of the family lacked maxillary second incisors. Doctor Davis mentioned three cases in his series in which the lip and palate cleft was accompanied by pits in the lower lip. The speaker has observed these in at least a dozen cases. Enlarged thymus is not infrequently found in babies with clefts of the lip and palate, and of course adds to the operative risk. Attention is called to this in a recent paper by J. A. Henske, of Omaha, in the *Journal of American Medical Association*, November 12, 1927, page 1666, who advocates routine X-ray examination for this condition. Pre-operative X-ray examination for enlarged thymus in cleft lip and palate cases is also routinely carried out in the clinic of Lyons, of Ann Harbor. One enlarged thymus has occurred in the last four cases in Doctor Ivy's clinic.

Regarding the technical procedures, the time of operation suggested by Doctor Davis for the various types of deformity is in accord with the general opinion, i.e., to close the anterior part of the cleft in the lip and alveolus before three months of age, and the posterior part from eighteen months to two and a half years of age. Closure of the lip alone in most cases will take care of the cleft in the alveolar process without making a greenstick fracture or putting wire through this portion of the bone. If extreme care be not used in bringing back the protruding premaxilla, either in single or double cleft, it is apt to be carried too far back, with resulting flat upper lip. Where a V-shaped piece of the vomer is removed in double cleft with protruding premaxilla, rotation is apt to cause the incisor teeth after eruption to project backward instead of downward and slightly forward. The speaker prefers to slide the protruding bone downward and backward without rotation. He has not found that on-end mattress sutures for the mucoperiosteum of the hard palate cause sloughing, but rather favors union by bringing broad

## HARELIP AND CLEFT-PALATĚ

raw surfaces together. In bringing the horizontal bony plates of the palate together, the speaker wished to ask how the holes through the bones for introduction of the wires were made.

DR. W. B. DAVIS remarked that there are many points which show the individual differences in operative technic. Doctor Ivy's experience with the mattress sutures differs from his; also the different types of cases in the two series. In regard to rotation of the premaxillary bone, the speaker is careful not to remove too large a section and estimates the base of a triangle just sufficient to allow the rotation necessary. In one case seen several years ago, in which an attempt had been made to repair the lip deformity, the incisor teeth were going through the upper lip; that is the other extreme. The suture through the bony flaps is another advantage in the two-stage operation. Some years ago Doctor Davis tried the method of Rowe who advocated operation in one stage; he had little drills and put the sutures through with small straight needles and a specially devised needle holder. It is surprising how much these pieces of bone soften up in one week, as shown by the two-stage operation. Now the speaker uses a curved needle and carries the wire through from one side and catches it with a specially devised hook like a crochet needle on the opposite side.

# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

*Stated Meeting Held December 14, 1927*

The President, DR. FRANK S. MATHEWS, in the Chair

### EMPYEMA FOLLOWING PNEUMOTHORAX THERAPY FOR TUBERCULOSIS

DR. HAROLD NEUHOF presented a man, forty-six years old, who had been the subject of a widespread pulmonary tuberculosis of the right side that began seven years ago. Pneumothorax therapy was employed for two and a half years. The patient did very well; the sputum became scanty and free from tubercle bacilli and he has remained apparently well of his tuberculosis up to the present time. About three years ago there suddenly began severe pain in the right chest and the expectoration of a large amount of pus. Since that time the sputum was profuse, averaging about two cups daily, not foul, and was brought up with very little effort. About three months before he came under the reporter's observation, he had some grippelike manifestations, since which time the sputum has become more profuse and thicker. It then became necessary for him to empty the cavity by leaning over the bed three or four times a day. There was vomiting with cough efforts. The patient could not lie on his left side and there was progressive deterioration in his general condition with loss of about ten pounds in weight. Sputum examined now, as before, was negative for tubercle bacilli.

When the patient came under observation, June 15, 1927, he was obviously considerably emaciated, had slight dyspnoea, and was constantly coughing with the expectoration of pus. Examination of the chest showed pronounced retraction of the right side with almost imperceptible respiratory excursion. Percussion note was flat throughout. An X-ray plate of the chest showed the heart and trachea drawn over to the right side; no evidence of pulmonary involvement on the left, and the dense parietal shadow of a chronic empyema cavity. The empyema reached from the base of the mid-axilla.

The first operation, performed soon after the patient had been seen, consisted in the free resection of two ribs over the axillary portion of the empyema with widespread freeing of the parietal membrane. This was dense, greatly thickened, fixed, but could be separated from the inner surface of the ribs by sharp and blunt dissection. After it had been freely mobilized, a considerable dead space remained. It was filled anteriorly by a flap made from the pectoralis major and posteriorly by a flap made from the latissimus dorsi. The soft parts and skin were sutured without drainage.

After this operation, the amount of sputum rapidly diminished, and at the time the patient was discharged from the hospital, one month after operation, the sputum was greatly reduced in amount. He did well for a while, but in about another month more profuse expectoration of pus began and the daily amount increased progressively, although it never reached the quantity that existed before operation. The patient was therefore re-admitted to the hospital four months after the first operation. Lipiodol was injected into the empyema cavity and demonstrated that the space was smaller than that pre-

## RECURRENT CARCINOMA OF CHEST WALL

viously existing, but also showed a free communication with the bronchial tree.

At the second operation, it was determined to attempt a wide resection of the parietal membrane. Obviously all could not be removed, but at the same time it was thought a free removal would offer the best outlook for an approximation between the soft parts of the chest wall and visceral membrane. Operation was performed under local anaesthesia about five months ago. It consisted in a vertical incision carried across the pectoralis major and down toward the mid-axilla. Large sections of the third, fourth and fifth ribs were removed. The dense parietal membrane, widely exposed, proved to be an inch or more in thickness and was resected down to a thin shell of more pliable tissue directly upon the empyema cavity. The cavity itself was entered in several places. The result of this excision was a flapping membrane capping the empyema cavity. Into the space left after excision of the pleura, the margins of the divided pectoralis major were turned. Soft parts and skin were closed.

The patient did well for three days after operation and then began to run temperature with increasing pulse rate and dyspnoea. He was treated with the tentative diagnosis of pneumonia. After ten days temperature gradually subsided, and the sputum that had already greatly diminished in amount was reduced to a half to one ounce daily. In another two weeks the sputum was very scanty, and then completely disappeared. There has been no return of purulent expectoration up to the present time. Considerable serum accumulated in the dead space of the wound and this was treated by repeated evacuation and compression dressings. The soft parts gradually were drawn in to fill the dead space, so now there is a deep depression in the operative field. The patient has gained gradually in weight and strength, feels well and has returned to his occupation.

## RECURRENT CARCINOMA OF CHEST WALL FOLLOWING MASTECTOMY. RESECTION OF CHEST WALL WITH FASCIAL GRAFT FOR THE PLEURAL DEFECT

DOCTOR NEUHOF presented a woman, fifty-eight years of age, who eight years ago presented a typical recurrent carcinoma of the chest wall at the mesial end of an operative scar. The operation had been done ten years before, and although data could not be obtained, it had obviously been a radical one for carcinoma. The mass was sessile; the overlying skin adherent; it was about one and a half inches in each diameter and fixed to the chest wall. The second and third ribs and the intercostal tissues near the costochondral junctions were involved. At operation, under intrapharyngeal anaesthesia, the second and third ribs were divided beyond the lateral aspect of the tumor. The parietal pleura was stripped away toward the tumor and was then found to be adherent to the deep surface of the neoplasm. The free pleural cavity was therefore entered and the chest wall freely sacrificed around the neoplasm. The internal mammary vessels were secured above and below, and the removal of the portion of the chest wall bearing the tumor was completed by carrying the dissection through the second and third rib cartilages. A sheet of fascia lata about three inches in each diameter was detached from the thigh and fixed into the pleural gap by four sutures of fine catgut. Continuous sutures then approximated the pleural margin to the margin of fascia. As the last sutures were placed, the intrapharyngeal pressure was increased in order to bring the lung up to the surface. A wet compress was

then placed over the graft in order to control any air leakage that might occur. The skin was then freely mobilized and carefully closed as the wet compress was withdrawn.

There was no air leakage and no pneumothorax after operation. This was confirmed by a series of post-operative X-ray pictures.

The patient has remained well since operation. There has been no interference with pulmonary mobility. A recent X-ray examination of the chest was negative. The operative field is occupied by mobile skin overlying a rigid membrane continuous in contour with the chest parietes. On coughing or straining this membrane is resistant and does not bulge.

DR. JOSEPH WIENER said that twenty-two years ago he amputated the left breast of a lady for carcinoma and she remained free from the disease for ten years. She then came back with a scirrhus carcinoma of the other breast, far advanced. It was removed but there was recurrence in the scar within a month and this included the chest wall. The case seemed hopeless but the speaker did a radical secondary operation and during the eleven years that have since elapsed she has remained entirely free from any further recurrence.

#### INFECTED CONGENITAL CYST OF LUNG IMPROVED BY MARSUPIALIZATION AND DRAINAGE

DOCTOR NEUHOF presented a woman, thirty years old, who came under his observation at Montefiore Hospital one and a half years ago. The history was of a year's duration with slight cough and expectoration. These manifestations continued for six months. There then occurred a sudden onset of fever, chill, pain in right chest and more active cough with more profuse expectoration. A diagnosis of right-sided pleurisy was made. Fever and other manifestations continued for a few days and then the acute symptoms subsided. For six months, however, there has been almost continuous cough with expectoration of small quantities of mucopurulent sputum. On admission to the hospital the appearance of the patient suggested suppuration of long standing. There was a large area of dullness to percussion in the lower right chest posteriorly with almost absent breathing. These physical signs suggested an empyema near the mediastinum. The X-ray picture disclosed a dense homogeneous shadow in the lower right chest arising broadly from the region of the mediastinum. This free margin was smooth and globular, and those who saw the plate believed the condition either a mediastinal abscess, or an empyema at the mediastinum. An aspiration was done and purulent material was withdrawn, which was found to be sterile on culture.

The first operation was performed on June 1, 1926. Under local anæsthesia, sections of the eighth and ninth ribs close to the midline were freely removed subperiosteally. The pleura was stripped away in order to enter the mediastinum. The latter was exposed with negative findings. It was, therefore, assumed that the lesion was an encapsulation of pleural pus. No adhesions were noted through the unopened pleura, the lung surface moving freely. On the assumption of a lung abscess, the pleural cavity was opened and the surface of the lung examined. A well-defined hemispherical bulge of the lower lobe was then noted. This part of the lobe was packed off from the remainder of the pleural cavity and the wound packed. Aspiration was done and pus obtained. Spreads and cultures were again found to be sterile.

At the second stage operation, eleven days after the first, the lung was freely entered until pus was encountered at a depth of about an inch. A large amount of pus was withdrawn by suction, and it was then found that the cavity, occupying a good part of the lower lobe, presented an absolutely smooth wall. Part of this was excised for diagnosis. Digital exploration of the cavity disclosed the wall of a bronchus on its mesial aspect. The rings in the bronchial wall could be felt through the thin overlying membrane of cyst wall, but there was no direct connection between the bronchus and cyst. The lung at the site of entry into the cyst was sutured to the soft parts of the incision in order to bring the cyst nearer the surface. A tube was inserted.

A microscopic examination of the wall of the cyst showed it to be lined by ciliated epithelium of bronchiogenic character.

The immediate post-operative course was satisfactory. There was gradual diminution in the amount of the secretion and shrinkage in the size of the cyst, as determined by measuring the fluid and by filling it with sodium bromide solution and X-raying thereafter. Cough and sputum have entirely disappeared. General condition progressively improved. The cavity now holds ten to fifteen cubic centimetres of fluid and a fine tube is left in place as a safety valve.

#### LOBECTOMY FOR BRONCHIECTASIS WITH BRONCHIAL FISTULÆ

DOCTOR NEUHOF presented a woman, now twenty-five years old, who had had a series of operations on the chest wall and lung that began when she was two years old. The first operations in 1903 and 1904 consisted in rib resection for empyema and drainage for abscess of lung. A large cavity remained and subsequent operations were apparently undertaken in order to reduce the size of this cavity. These were operations carried out when she was twelve years old, at the age of fifteen and at the ages of eighteen and twenty. At these operations rib resections were the essential part of the procedure. For many years there has been a profuse mucoid discharge from the wound, estimated at a cup or two daily. As long as the patient can remember, the wound has wheezed upon straining or coughing. Other than the usual manifestations of colds, the patient has had no cough and no expectoration. Her general health has been good and she has withstood the various operative procedures without any difficulty.

The patient first came under the reporter's observation in November, 1925. She was a well-nourished, well-developed young woman and the physical examination was negative, except for the chest condition. There was marked asymmetry of the chest with sharp scoliosis to the left of the mid-dorsal spine. There were numerous scars over the back, representing the removal of large sections of most of the ribs. The thoracic cage was almost completely gone over the left postero-lateral aspect of the chest. In the midst of scar tissue was a large triangular space covered by smooth, red, velvety, mucous membrane, broadest at the base and narrowing toward the top. This smoothly lined cavity appeared to represent an empyema space. On its mesial surface were numerous bronchial fistulæ from which air and profuse mucoid material escaped upon any straining effort. In the region of the bronchial fistulæ, cardiac pulsation beneath the velvety membrane was obvious, and the finger placed here gained the impression of an almost direct impact from the left ventricle. The X-ray of the chest showed an almost complete obliteration without any lung markings being visible. At the first operation, November 24, 1925, an attempt was made to cover the region of the bronchial

fistulæ with a skin-muscle flap. This was dissected free from the posterior part of the wound with great difficulty because of extreme vascularity. Each short incision was accompanied by active bleeding from arteries and veins, so that numerous hæmostatic sutures had to be passed. An attempt was made to mobilize the tissues about the bronchial fistulæ, but this had to be discontinued because of excessive bleeding. The skin flap was laid in place and the wound packed. The result of operation was some diminution in the size of the cavity, but no change in the local condition as far as bronchial fistulæ and profuse discharge were concerned.

The patient returned to the hospital, February 8, 1926, where an effort was made to mobilize the lung in the hope that the fistulæ could be brought to the surface in a more favorable position for a subsequent effort at closure. At this operation, an incision anterior to the gutter in the chest wall was made. Here again numerous greatly enlarged vessels in the chest wall were encountered. After securing them, long sections of two ribs that had reformed after previous operations were freely excised. Under them a dense fibrous membrane was encountered. After this was traversed, surprisingly healthy lung tissue lay exposed. The adhesions fixing this part of the lower lobe were divided, chiefly by blunt dissection. With increased pharyngeal pressure this lobe was found to balloon up in an extraordinarily free manner, as if it had only been in that collapsed state for a relatively short period of time. More separation of the lobe was carried out until the lung expanded sufficiently to obliterate a large part of the empyema cavity. The incision was then closed.

After operation, forced breathing exercises were carried out and it was found that the lung expanded enough to thoroughly obliterate the dead space. At the time of discharge from the hospital, the bronchial fistulæ were much more superficial but discharge from them was as profuse as before. The patient returned to the hospital, January 3, 1927, with the request that a radical operation be attempted in order to obtain a cure. Examination showed that the lower lobe of the lung expanded well, partly obliterated the empyema space, but that the discharge from the bronchi was quite as profuse as before.

At operation the old scar of the chest wall was freely incised upward to lay open widely to inspection the visceral surface of the cavity. There were seen a series of dilated, open-mouthed bronchi extending from the upper limit of the operative field (which proved to be the upper limit of the lower lobe) downward a distance of about 12 cm. These fistulæ could be roughly divided into two groups, an upper one, near the interlobar incisure, and the lower close to the surface of the diaphragm. A trabeculated, glistening membrane covered the surface of the lung between these fistulæ. The latter were about twenty in number. The lower lobe was densely adherent to the remains of the chest wall posteriorly and, on the mesial aspect, intimately attached to the postero-lateral aspect of the pericardium. The lobe shaded almost imperceptibly into the adjacent portion of the upper lobe. Its lower limit was almost indistinguishably continuous with the diaphragm. During the course of the lobectomy the bronchi were found dilated and thick-walled and contained muco-pus or pus.

As noted above, the first step of the operative procedure was to split open the old scar tissue in the chest wall for adequate inspection. Relatively little bleeding occurred and this exposure without any rib resection sufficed for the removal of the lung. The first step was an effort to peel away the



## ANKYLOSIS OF KNEE FOLLOWING OSTEOMYELITIS

lobe from the remains of the posterior chest wall. In doing this the anterior surface of the bodies of the vertebræ were exposed and the midline was passed without gaining much mobilization. No further effort was made at freeing the lobe at this direction. The next effort was to find a separation between the lobes. This was very difficult, and lobectomy was begun with partial inclusion of the upper lobe with series of chain sutures that were placed. The procedure was to include pulmonary tissue in a stout suture, apply a clamp, and divide pulmonary tissue between clamp and suture. Such sutures were applied one after the other, working from the general region of the hilum and above the uppermost bronchial fistulæ. In this manner the upper part of the lobe could be largely detached. An effort was then made to free the lower part of the lobe. This at first could not be accomplished because no line of cleavage from diaphragm could be found. Active bleeding occurred which was only partially controlled by sutures. It was obvious that an adequate operation could not be carried out unless the lower lobe could actually be freed from diaphragm. Accordingly, another effort was made by sharp dissection, and a plane of cleavage was found through the dense cicatricial tissue that bound the lobe to diaphragm. The lobe could then be freed here, largely by blunt dissection, and the hilum was thereby freely exposed. It was intimately adherent, and could not be detached in part, from the pericardium. Therefore, a number of pedicle sutures were passed through the dense scar tissue on the posterolateral surface of the pericardium, and this portion of the hilum was thereby freed. The remainder of the hilum was transfixed by stout chromic sutures in chain series and the lobe was thereby freed and removed. Operation had been conducted under intrapharyngeal anæsthesia, which was now raised as the wound was partly closed. The pedicle sutures were left long and the wound lightly packed with iodoform gauze.

The specimen consisted of a lobe that was partly fibrous but partly aerated, traversed by thick-walled, dilated bronchi containing muco-pus. Microscopic examination showed bronchiectasis with interstitial and suppurative pneumonitis.

The immediate post-operative course was characterized by dyspnœa. This gradually subsided and the patient was convalescing on the tenth day of operation. The chromic ligatures around the pedicle disappeared by absorption and the wound rapidly began to granulate. There was no fistula formation from the bronchial stumps. The wound rapidly contracted in size, and at the time of discharge from the hospital was a clean granulating area.

It is now one year since operation. The patient has remained in good condition and the local condition is a small patch of parietal membrane that had not been removed at operation. Slight secretion occurs from this, and at some future time it may be necessary to excise this patch to permit complete closure of the wound. At no time has there been a return of any bronchial fistulæ.

## ANKYLOSIS OF KNEE FOLLOWING OSTEOMYELITIS

DR. JAMES M. HITZROT presented a young woman who was admitted to the New York Hospital on September 3, 1921, when she was fourteen years old, with an acute osteomyelitis of the right femur of three days' duration. The onset was sudden and on admission the lower end of the femur and the region of the knee-joint were swollen, red and very tender. Temperature on admission was 104, white blood-cells 18,000, 88 per cent. polymorphonuclears.

At operation, September 4, by Doctor Farr, by an external incision a focus of infection was found on the posterior surface of the femur just above the external condyle. This was drained with a rubber dam. September 15, the bone focus was more widely opened, and September 18, an abscess on the inner aspect of the thigh was opened and drained.

September 29, both wounds were explored (Hitzrot) as the child's condition was not satisfactory and a large abscess had appeared over the internal tuberosity of the tibia below the knee. About half of the circumference of the lower end of the femur was white and apparently necrotic, but had not sequestered. The bone focus previously treated by Doctor Farr seemed to be draining properly. The superficial abscess was opened and drained.

Frequent X-ray examinations thereafter showed an osteomyelitis of the lower end of the femur with considerable new periosteal bone, but no evidence of sequestration up to the thirtieth day after the onset.

The cultures taken showed a pure culture of *Bacillus coli* on only one occasion (that taken at the first operation), all the others were overgrown by the *Bacillus proteus*.

Throughout this period the wounds were treated by the Carrell-Dakin method. She left the hospital, with a granulating sinus, on her fifty-sixth day, with as yet no evidence of sequestration of the exposed and apparently necrotic shaft of the femur.

Following her discharge from the hospital, the leg was allowed to become flexed to a right angle and was held in the flexed position and the child would not straighten it.

She was readmitted December 13, 1921, and the leg straightened by adhesive traction and weight. This was unsatisfactory, and on December 15, she was given an anæsthetic and the knee brought to within 15 degrees of complete extension and the leg put up on a posterior moulded plaster splint. She was discharged January 14, 1922, with the leg straight and some motion in the joint on a splint and disappeared and only had some casual treatment, the details of which they could not determine.

She returned March 13, 1922, with knee stiff and flexed to within 10 degrees of a right angle. X-ray examination at this time showed a definite change in the knee-joint with proliferative changes about the condyles of the femur. The dead bone was showing evidence of demarcation. The leg was straightened by traction and gentle manipulation under an anæsthetic and put in a circular plaster which was bivalved and she was sent to the convalescent home at White Plains, March 30.

She returned to the hospital thirty-four days later (May 3) with fever and an increase in the discharge from the outer sinus and the X-ray examination showed definite sequestration of the dead bone.

Operation: May 4, osteotomy with removal of sequestrum (5 cm. by 1 cm.) from the lower end of the femur. Vaseline gauze packing followed by Carrell-Dakin. The wound healed rapidly and she left the hospital twenty-two days later with a knee brace to control the constant tendency of the flexion at the joint.

She was readmitted August 23, 1922, with the knee in about 20 degrees of flexion and stiff. An X-ray at this time showed an ankylosis of the knee-joint with the joint space poorly defined and the cartilage apparently gone from the femur and possibly the tibia. Under anæsthesia the leg was corrected so that only about 10 degrees of flexion deformity remained and the leg was fixed in this position. The patella was united to the femur and

## POST-TYPHOID OSTEOMYELITIS

considerable effort was necessary to correct the deformity. She was splinted in this position and disappeared.

Three years later, July 25, 1925, she returned to the hospital with the knee ankylosed in about 10 to 15 degrees of flexion. All the wounds were healed and had caused her no trouble since she left the hospital three years previously. At this time her age was given as seventeen. This corresponded to the appearance of her epiphyseal line in the X-ray more nearly than the age fifteen, if she was eleven years old on her first admission. The X-ray examination showed practically an obliteration of the joint with bony fusion between the patella and femur and a complete disappearance of the joint cartilages.

Arthroplasty was proposed and done, July 30, 1925, by the method proposed by McAusland, using a fascial graft from the opposite thigh to cover the lower end of the femur and reshaping the joint. The leg was put in circular plaster for five days and then in an extension splint (Thomas splint with knee attachment) and motion begun on the tenth day. She left the hospital in thirty-two days with about 20 degrees of motion in flexion in the joint. The joint was moved twice under anæsthesia and about the same motion obtained each time, but the patient meanwhile made no attempt herself to continue the motions and in the follow-up of January, 1926, was reported as unsatisfactory and the case considered closed, as she refused to return.

She returned one year later, January 26, 1927, with about 10 degrees of flexion and promised to continue treatment. Manipulation under anæsthesia was then done at repeated intervals of about six weeks and the leg flexed to about 10 degrees beyond a right angle. At present extension is practically complete, there is active flexion to a right angle and the knee is stable in the extended position with no lateral movement.

The case is shown to present the difficulties to be met with in the reconstruction of a knee-joint and the late result in what promised to be an unsatisfactory reconstruction. It is also shown to advocate the use of the method advised by McAusland which in the reporter's hands has given results much superior to other methods.

## POST-TYPHOID OSTEOMYELITIS

DR. JAMES M. HITZROT presented a young man now thirty-one years old, who was admitted to the New York Hospital in May, 1915 (twelve years ago), with an ankylosis of the right knee and left shoulder following an attack of typhoid fever ten years previously (1905) when he was nine years old.

During the fourth week of the disease he developed multiple abscesses with pus in the right knee and left shoulder. After a long convalescence he recovered with the knee stiff, in about 90 degrees of flexion and a stiff shoulder. When he entered the hospital there was a bony ankylosis of the right knee well shown in the X-ray. There was also an ankylosis of the left shoulder with evidences of erosion of the head of the humerus and the glenoid fossa and a fusion of these two surfaces which was probably only partially bony. There was marked atrophy of the right leg and a definite shortening of about eight inches in measurement in the leg due to lack of growth. He could not walk because of the flexed position of the knee, which increased the shortening of the leg.

Osteotomy with resection and a correction of the deformity was done

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May 21, 1915, and he was discharged in plaster with the leg in the corrected position, fourteen days after the operation. The fusion became solid in eight weeks and he was able to walk with a raise of three inches in the shoe. Since that time he has led an ordinary active existence with little trouble.

November 21, 1927, he returned stating that recently his left shoulder had begun to ache after use, and the motion that he previously had was gradually disappearing due to the pain.

X-ray examination shows a progressive destruction of the head of the humerus and apparently an absorption of the bond between the humerus and scapula which possibly explains his pain and disability.

X-ray examination of the knee shows a complete bony fusion.

The case is shown to demonstrate a complicating lesion of typhoid fever with the late result in the resected knee and the untreated shoulder.

### ULCERATIVE COLITIS

DR. JAMES HITZROT presented a man, fifty-three years old, who for twenty-five years had had diarrhoea, causing from three to six or more watery stools a day. The stools occurred after eating and occasionally contained a little blood and some mucus. Throughout he has had a little gas and some discomfort. His chief difficulty was the insistent desire to go to stool and his inability to control this desire. During this period he has had practically every variety of medication and colon irrigations without any relief.

In December, 1926, he had a profuse hemorrhage (intestinal) with collapse for which Doctor Carter sent him to the Presbyterian Hospital, where he received two transfusions with distinct benefit. Doctor Hitzrot saw him in consultation with Doctor Whipple and Doctor Carter and after considering the various conditions to be met, a cæcostomy with irrigation was decided upon as the best course to pursue. An X-ray at this time showed a curious mottling with spasticity. The cæcostomy was done by Doctor Whipple under local infiltration anæsthesia January 14, 1927. Irrigations of 1-10,000 and later 1-5000 acro-flavine were given through the cæcostomy wound. His general condition improved. His blood picture showed 4,000,000 red blood-cells, hæmoglobin 75, leucocytes 9200 with a normal differential after leaving the hospital.

His previous history was unimportant except for an exploratory operation fourteen years ago, in which his appendix was removed without relief. His father died at eighty-two with some condition in the colon, probably a carcinoma, and his mother died at seventy-five with kidney disease.

After leaving the Presbyterian Hospital he was given acro-violet irrigations twice daily through the cæcostomy wound and a low residue diet. For about a month he seemingly improved. An X-ray picture taken about six weeks (February 24, 1927) following his operation, however, showed essentially the same mottling and spasticity of the colon which had existed before the cæcostomy and his blood picture began to show an increasing anæmia.

He then entered the New York Hospital, where his blood picture was: hæmoglobin 58, red blood-cells 3,000,000, leucocytes 9000, with a normal differential count, and he was transfused and given 600 c.c. of blood on March 12, three days later he was operated upon.

Operation, March 15, 1927, ileo-sigmoidostomy. After opening the peritoneum and freeing the omental adhesions the colon was examined. The

## ULCERATIVE COLITIS

rectum and the sigmoid flexure were somewhat thickened, but other than the thickening of the walls, it seemed to present no abnormal characteristics. The descending colon and a portion of the transverse colon were markedly thickened and when palpated seemed to contain a number of nodular masses which moved with the palpating finger. This condition existed to a lesser degree in the hepatic flexure and down to the cæcum. The only difference in the cæcal region was a rather voluminous condition with thinning of the walls as compared to the very thick walls of the ascending colon.

The small intestines seemed fairly normal, although the coils of the ileum seemed a little hypertrophied and the gut seemed a little thick as one approached the cæcum. At no point was there any definite induration nor did there seem to be any infiltration of the walls suggesting ulcer of small bowel.

The terminal ileum was matted together in the pelvis and adherent to the parietal peritoneal wall. This was liberated with a little difficulty due to the fact that the adhesions had to be separated by sharp dissection in order to free the gut. When the gut was freed and delivered, it was necessary to choose a portion of the ileum a little further away from the ileocæcal valve than was ordinary, because of the raw surfaces left by the liberation of the gut from its fixed position in the pelvis.

The sigmoid flexure was also adherent on its lateral aspect by a group of rather fine non-vascular adhesions which became more marked as one ran up the ascending colon. That portion of the sigmoid which lay on the pelvic brim on the left side was then liberated sufficiently to mobilize it and brought toward the median line.

The ileum was then clamped and divided and one portion of a Murphy button placed in the open end of the proximal side. The mesentery was divided sufficiently to allow the ileum to reach the sigmoid without any tension. The other half of the Murphy button was then placed through an opening in the wall of the sigmoid. So far as could be determined through the small opening in the sigmoid, there were no polyps and nothing to indicate an ulcerative condition in the bowel selected for the anastomosis. The two portions of the button were placed together approximating the gut. The line of this approximation was further reinforced by two rows of interrupted chromic catgut stitches, and the mesentery fastened to the meso-sigmoid by interrupted catgut stitches. The posterior surface of the fossa was closed by interrupted catgut stitches crosswise, thus obliterating the space left by the rotation of the ileum. The distal stump of the ileum was then excised, leaving the stump about two and one-half cm. from the ileo-cæcal valve and this was closed by four layers of chromic stitches, the first layer being completely through the mucous surfaces.

The stomach and gall-bladder were apparently normal except for a few adhesions in the neighborhood of the duodenum which were not disturbed. A rubber dam drain was placed to the bottom of the pelvis as there was quite a little oozing from the region from which the ileum had been removed. This oozing was serosanguineous rather than frankly bloody. A rubber dam drain was placed in contact with the raw surfaces and brought out through the lower angle of the wound. The wound was closed in layers about the drain, using five silkworm tension stitches. No attempt was made to reconstruct the abdominal wall in the region of the old operative scar, but it was closed by through-and-through sutures.

His convalescence was uninterrupted except for some irritation about one silkworm stitch which broke during removal and had to be removed later.

He left the hospital on his thirty-second post-operative day considerably improved.

Since that time he has kept up his irrigations, using 1-10,000 acro-violet at first daily, recently every second or third day and alternating them with saline solution.

Repeated skiagraphs have been taken since the colectomy. At the last one taken October 1, 1927, the barium enema filled the colon completely. The haustrations, however, were completely absent, and the colon had a smooth ironed-out appearance. There were no shadows indicative of the presence of polypi. As the barium entered the colon during the fluoroscopic examination, the transverse colon showed quite marked spasm; this was not so noticeable, however, when the films were exposed. Twenty-four hours after the enema was given the cæcum still retained considerable barium and there also was some in the ascending colon.

His improvement has been continuous and his latest examinations show a continued improvement. He has gained some weight and his general health and strength have improved. His blood picture now shows hæmoglobin of 80 per cent., with red blood-cells 4,500,000. At present he has four stools a day, but the previous urgency has gone. Throughout he has carried out his own irrigations and now takes them at intervals necessary to keep the colon empty, approximately every third day.

Cultures from the stools have given no information of any value either as to the cause of the ulceration or the reason for the improvement.

This case is shown to illustrate the value of cæcostomy with colon irrigations supplemented by ileosigmoidostomy, in an obstinate case. The only new feature is the use of acro-flavine and acro-violet suggested to me by Churchman.

Doctor Hitzrot added that he had used cæcostomy with irrigation in ten cases, in nine simply the cæcostomy and in the tenth, the case shown here supplemented by ileosigmoidostomy. One case died of inanition two weeks after the operation. A second case allowed the cæcostomy wound to close as soon as the diarrhoea had ceased, his symptoms returned and he has constantly grown worse. One case was allowed to close after being free of symptoms for a year and remained well for eighteen months. Then his symptoms recurred and his cæcostomy was again established. This case has been under observation five years and is well as long as he keeps up his irrigations. Six cases are still under treatment, two cases two years, three cases one year, one case four months, and all are markedly benefited. To say cured is doubtful.

The method used is briefly as follows: A valvular cæcostomy by the Gibson method is done through a right McBurney incision, removing the appendix for microscopical examination. No facts of any importance have so far resulted from the examination of the appendices thus removed.

If a wide examination is considered desirable, exploration may be done through a rectus incision with the cæcostomy after the exploration through the McBurney incision. This is better than the use of the right rectus incision alone, because wound infection is a definite possibility and may interfere with the subsequent use of the cæcostomy and to that extent defeat the principle upon which the treatment is based. The colon as far as is possible is examined and as a rule its wall is altered in character, thick oedematous and with a generalized leathery feel. The oedema may whiten the colon so that it looks pale and anemic and does not redden upon exposure

## ULCERATIVE COLITIS

to air as in the normal gut. A valvular cæcostomy by the Senn or Kader method is then done in the cæcum and a number 20 to 22 French catheter is fastened into the wound in the cæcum and into the skin. The patient is put upon a low residue diet.

The chief therapeutic measure, however, has been irrigation of the colon through the tube in the cæcostomy opening. Various substances have been used such as dilute silver solutions, dilute quinine solutions, saline, and dilute salts of mercury with varying degrees of success. At the suggestion of Churchman (personal communication) gentian violet, acro-flavine and acro-violet solutions were then substituted for the above with a greater success and a more rapid subsidence of symptoms.

At first 1-10,000 acro-flavine is used followed by 1-10,000 acro-violet. This is gradually increased in strength until 1-5000 is used daily. The quantity tolerated by each individual varies, but as a rule two quarts are readily tolerated. The frequency soon stops. If there is much bleeding tannic acid sufficient to make a half per cent. solution is added to the first quart for several days and seemingly is efficacious. At first, or until the cæcostomy wound is firmly established, the tube is kept in place constantly (about twelve to fourteen days). It is then removed and introduced daily. The patient is trained to use irrigation himself and readily learns method.

As soon as the symptoms are under control and the patient is gaining in weight, saline is substituted for the other irrigations and may be done on alternate days. Just when to allow the cæcostomy wound to close is a question. In one of these cases it has been kept open for five years as the patient's condition recurred after it was stopped.

In the cæcostomy cases the tendency of the skin opening to contract can be counteracted by allowing the tube to stay in place during a part of the day or by wearing a hard rubber obturator conveniently made from the ordinary hard rubber stem pessary, sufficiently long to enter the gut, and fastened into the wound by a piece of adhesive and worn on alternate nights for two or three days at a time.

The cæcostomy may be kept open for five years or longer. Leakage does not occur and the cæcostomy opening is readily protected by a small patch of adhesive plaster or the ordinary vaccination shield. All the patients now under treatment are back at their ordinary occupations and do not consider their irrigations of greater significance than the ordinary daily duties.

In one of his earlier cases colectomy was done for an ulcerative colitis after improvement under cæcostomy with a fatal result. He does not believe that colectomy is advisable because of its high mortality.

DR. HAROLD E. SANTEE called attention to recent literature which had come from the Mayo Clinic where experiments had been conducted which seemed to show that there is a diplococcus which is specific in the deep-lying ulcers of this condition. It apparently, however, does not account for all the cases. In the treatment of this case valvular cæcostomy was done. The speaker asked Doctor Hitzrot if he believed the irrigations brought about the good results in his case or whether a large cæcostomy might have been an important element in the amelioration of the condition by giving the colon surgical rest to some degree.

DOCTOR HITZROT replied that he had not been able to grow any organism

which could be considered specific and in his opinion there is no organism which is specific for this disease. The work of the Mayo Clinic on the cases that have had accessible ulcers is interesting, but the case shown this evening did not have ulcers in the rectum. In two of the other cases in which scrapings were made from the floor of an ulcer, no specific organism was found. With regard to cæcostomy, when this was done it was merely to facilitate giving the irrigations and not to put the colon at rest. The case presented this evening is the only one of the group in which the ileum was attached to the sigmoid. The other cases did very well with irrigations alone.

#### DEVELOPMENTAL MEMBRANES CAUSING OBSTRUCTIVE SYMPTOMS

ALFRED S. TAYLOR presented a young man, twenty-three years of age, with the following history: Birth at full term, vertex, instrumental delivery. Repeated vomiting and constant constipation for first three months, then vomiting stopped, but constipation has always persisted. At three years old he had sudden obstruction, distention, pain and vomiting. Ceased suddenly after twelve hours. At seven years of age a sudden obstruction, with fever and delirium lasting twenty-four hours.

All through his life there have been frequent periods of somnolence and fatigue which could be cleared up by catharsis. At twelve years of age the tonsils were removed. At fourteen years of age (1918) a gangrenous appendix was removed. Since one and a half years of age he has had chronic left ear trouble, perforated drum, deafness and recurring discharge every six months.

In 1914 (ten years of age), after great physical and nervous fatigue, he had his first convulsive seizure preceded by dimness of vision and hearing. Later attacks occurred at intervals of five to eight months until the appendix operation, after which none appeared for eighteen months, then returned to their previous schedule. Often for several days preceding an attack he would be irritable and depressed and pale, but it was not noted if the constipation was aggravated. Many attacks were followed by persistent vomiting. In playing on his school foot-ball team he has noticed for a long time that bending forward and downward would always cause vertigo and associated discomforts (mastoiditis with cholesteatoma).

Physical examination in 1920: He was a well-developed boy in good general condition. The only neurological finding was slow nystagmus to the right and rapid to the left. Teeth infected: right upper lateral incisor apical abscess; lower right third molar partly erupted and infected. The left ear showed perforated drum; some discharge, some deafness, and X-ray plates showed much involvement of the bone (cholesteatoma).

Gastro-intestinal series: Dilated stomach, elevation and distortion and angulation of the duodenal cap, adhesions between the beginning transverse colon and ascending colon; calcified glands to right of lumbar vertebræ.

Diagnosis: Epilepsy complicated by chronic toxæmia from: 1. Infected teeth. 2. Mastoiditis. 3. Digestive dysfunction due to hepato-duodenal membrane, pericolic membrane, and post-operative adhesions.

Treatment: 1. The mouth infection was disposed of. 2. The left mastoid was operated upon June 8, 1920, and a large cholesteatoma, involving the mastoid, the tympanic cavity and eustachian tube was removed with the drum



## DEVELOPMENTAL MEMBRANES CAUSING OBSTRUCTIVE SYMPTOMS

membrane and ossicles. The dura was exposed, was thickened, showed no evidence of perforation and was not opened.

The third stage advised in the treatment, namely: the operative correction of the abdominal anomalies, was postponed by the parents because of the very great improvement following the above two procedures. Ten months after the mastoid operation, April, 1921, following a digestive upset with marked constipation, he had a convulsive seizure. An abdominal operation was again advised but not accepted.

During the last six years by following a careful dietary régime, by taking strenuous exercise (tennis, foot-ball, etc.) he has gotten on very well. During four college years he had only one attack which, curiously enough, occurred during vacation at home when he was not taking much exercise and the diet had been expanded somewhat. After graduating in June, 1927, he returned home to sedentary pursuits; immediately developed marked abdominal discomfort with frequent attacks of distention and pain. In August, he had a number of severe convulsive seizures, more than he had ever had in so short a period. In September, he developed iritis in the left eye. At the Neurological Institute he was again carefully studied.

Findings: Iritis, left; apical abscess of upper left lateral incisor; no evidence of organic intracranial disease; gastro-intestinal series showed same as seven years ago and more definitely indicated fixation of transverse colon to cæcum with marked distention of the intervening loop.

The incisor tooth was extracted because of its probable etiological relation to the iritis.

Again operation for correction of the digestive disturbances was urged for two reasons: 1. For improvement in digestive comfort and nutrition. 2. Since throughout his whole history there had been a very striking association between abdominal disturbance (preceding) and the onset of his attacks (following) it seemed obvious that any improvement in his abdominal condition would react favorably on the other.

Laparotomy was done October 18, 1927, at the New York Hospital through a transverse right rectus incision.

Findings: Liver normal; gall-bladder normal. First part of duodenum held up and back, close to the cystic duct, by a short rigid edge of gastro-hepatic omentum. Also there was a fold of peritoneum from the under surface of the right lobe to the outer side of the cystic duct which ran down and fused with the parietal peritoneum in front of the descending colon. These two things caused angulation and compression of the duodenum. The stomach showed no intrinsic disease. There was no disturbance of the duodenojejunal angle. The omentum had origin from the colon starting near the splenic flexure and passing around the hepatic flexure and downward almost to the cæcum. Transverse colon ran down ascending colon and cæcum to which it was firmly adherent at the old appendix stump, and then turned upward to the left at a sharp angle, the gut from the cæcum to this angulation being filled with putty-like fæces. Beyond the kink the gut was empty. The omentum was adherent to parietal peritoneum in front of the cæcum and ascending colon up to the hepatic flexure which was sharply angulated and from which a tongue of omentum, 2 cm. wide, ran up and was adherent to the anterior edge of the right lobe of the liver.

Procedure: The duodenum was mobilized by division of the edge of the gastrohepatic omentum and of the adhesion to the liver. The cæcum and

colon were mobilized by division of the various adhesions and separation of transverse colon from cæcum and ascending colon. Some of the raw surfaces could be covered, but most of them could not.

The recovery was quite uneventful. Skin sutures removed on the eighth day. On the twelfth day in a violent sneezing attack about 3 cm. of the middle of the skin incision parted. There was no infection and no separation of the rectus sheath. After the first five days he ate a liberal mixed diet, had no gas or other discomfort and had two well-digested formed stools daily, using only a moderate dose of milk of magnesia each night. Now, after two months his digestive apparatus is functioning better than ever before. He has had no attack since operation, a fact of little significance because the interval is so short.

#### DIFFERENTIAL SECTION OF THE TRIGEMINAL ROOT IN THE SURGICAL TREATMENT OF NEURALGIA

DR. BYRON STOOKEY read a paper with the above title, for which see page 172, vol. lxxxvii.

DR. ALFRED S. TAYLOR said that when Doctor Stookey first presented this original piece of work before the State Medical Association, Neurological Section, in 1926, he could not feel entirely sure that this refined differential section of the posterior root would give freedom from recurrence of pain. However, the experience which Doctor Stookey has had in the intervening two years has shown no recurrence of pain in any of the group he treated by this method.

The foundation of his thesis in comparative anatomy and in embryology of the human would seem to be very solid. Clinical experience thus far seems to prove that differential section answers all the needs for curing neuralgia.

It has been particularly interesting to hear this paper which apparently pushes the subject of surgical treatment of trigeminal neuralgia to perfection, especially to one who has followed the history of trigeminal neuralgia during the past thirty years. At that time Doctor Hartley was doing the best work of the period. In those early days a large osteoplastic flap was made with the aim of entirely excising the ganglion itself. This was an extremely difficult procedure and removal of the ganglion, and especially its ophthalmic third, was unquestionably the cause of the many and very serious complications, sequelæ and fatalities that have always since been associated in the mind of the general practitioner with any form of operation for trigeminal neuralgia.

The development of the posterior root section suggested by Spiller, and first carried out by Frazier, was an enormous step forward in the surgical treatment of these cases. The complications and sequelæ were greatly diminished and the mortality was reduced to almost nothing. However, eye complications were still altogether too frequent and atrophy of the muscles of the face, because of avulsion of the motor root, was very disfiguring and

## PYLOROPLASTY FOR PERFORATED DUODENAL ULCER

somewhat inconvenient so that the next step in saving the motor root and finally the saving of the ophthalmic portion of the sensory root, as worked out by Frazier, were still other very marked advances in the treatment. Now, finally, with the procedure suggested by Stookey, first in 1926, after he had developed the technic over a considerable period of time, it would seem that ultimate perfection of the operation in that type of neuralgia has been reached.

In addition to the general surgical principle of not destroying any anatomical structure unless necessary, there is another strong reason for minimizing the destruction of the posterior sensory root, which is to minimize the loss of sensibility in the face. It is a common experience with patients who have been relieved of their pain by posterior root section to complain bitterly of the numb sensation of the face (and often of the mouth and tongue) which has replaced the pain. Most of the patients soon forget this numbness, but many of them do not. Therefore, it is a great advantage to have only as small a part of the face anæsthetic as is possible as long as sufficient has been done to eliminate the neuralgia.

*Stated Meeting Held January 11, 1928*

DR. EDWIN BEER in the Chair

## PYLOROPLASTY FOR PERFORATED DUODENAL ULCER

DR. WILLIAM CRAWFORD WHITE related the history of three patients, for whom pyloroplasty for perforated duodenal ulcer had been done by him as follows:

CASE I.—Male, age twenty-nine years. Admitted November 6, 1925. Operation four hours after onset of acute symptoms. The section revealed an acute perforation of a chronic duodenal ulcer, the size of a dime, situated on the anterior surface of the first portion of the duodenum. There was only a slight amount of exudate. The ulcer was excised and a Horsley pyloroplasty was performed.

The convalescence was uneventful under routine post-operative gastroenterostomy diet. He was last seen October 11, 1927, in excellent health. He had gained twenty-five pounds in weight. There were no abdominal symptoms whatever. He eats anything when he desires, without hesitation.

Post-operative X-rays were taken, August 22, 1927. "Plates made of the stomach show a wide, freely patent pylorus, with a pyloric deformity characteristic of a Horsley operation. The meal passes freely through the pylorus and duodenum and the stomach is completely evacuated at six hours."

CASE II.—Male, age twenty-five years. Admitted November 30, 1925, with a diagnosis of acute perforated ulcer of duodenum. Excision of ulcer, Horsley pyloroplasty. Operation five hours after onset. The section revealed an indurated ulcer  $1\frac{1}{2}$  cm. in diameter on the anterior superior surface of the first portion of the duodenum about 1.5 cm. from the pylorus. The ulcer was crater-like with hard edges.

The patient had an uneventful convalescence under routine gastroenterostomy diet. For about one year after the operation he was troubled with belching of gas after eating. He did not obtain complete relief with

diet and soda. Gradually he improved and when last seen, November 21, 1927, he was on a mixed diet with no gastric symptoms.

X-ray films, No. 9411, December 23, 1926, show a deformity of the pyloric end of the stomach and cap resulting from the Horsley operation and they show a wide patent pylorus with the stomach contents completely evacuated at six hours. The rapidity with which the meal leaves the stomach during the early stage of filling suggest too rapid emptying time.

CASE III.—Male, age thirty-three years. Admitted December 1, 1927, with a diagnosis of acute perforation of duodenal ulcer. Operation, excision of ulcer, pyloroplasty with drainage, was performed six hours after onset. There was an ulcer on the anterior surface of first part of the duodenum, one-half inch in diameter, one-quarter inch deep and perforated at its centre, with the escape of moderate amount of stomach and duodenal contents.

This operation was really a Heineke-Mikulicz instead of the Horsley.

Convalescence was uneventful except for an abdominal wall infection of a mild degree.

DOCTOR WHITE added that these three cases demonstrate a method of procedure which has not been used to any extent in the treatment of perforated duodenal ulcer. It has seemed to him that the closure of the perforated ulcer by a few sutures was not the best treatment. These ulcers, as a class, have thick indurated edges and the usual treatment has not removed the ulcer. It does not assure a removal of the pathology. On the other hand, the routine posterior gastro-enterostomy is inadvisable. In the first place, it spreads the infection in the peritoneal cavity; in the second place, it unduly lengthens the time of the operation; and in the third place, it does not remove the pathology. It has usually been said that a posterior gastro-enterostomy was indicated because of constriction at the pylorus due to inversion at the perforated site, but it has been well shown that pyloric obstruction, due to this cause, is very infrequent.

Excision of the ulcer at the time of the operation seems to be sound pathology and after the excision of the ulcer the use of the Horsley pyloroplasty is sound physiology. He did not mean to imply that this pyloroplasty is the operation of choice in treating chronic duodenal ulcers, but it seems that it can be well applied in this condition. The additional time required in relation to a simple closure is negligible.

DR. EDWIN BEER said that although perforated ulcers seem to heal after ordinary suture, there was no particular objection to making an excision such as had been done by Doctor White. In Germany, Kreuter has even gone further than Doctor White (whose technic has also been employed repeatedly in the Fourth Surgical Division of Bellevue Hospital, with far from satisfactory results) and advocated gastrectomy in perforated ulcers; and in a series of some sixty-five cases he claims a lower mortality than that from simple suture of the perforation.

DR. E. W. PETERSON said he had had no personal experience in the treatment of acute duodenal perforation by the Horsley operation, but that his

## MELANOMA OF BUTTOCK

associate, the late Dr. Walter M. Silleck, had performed the operation a number of times, at the Harlem Hospital, and was enthusiastic about the immediate results.

## FIBRO-SARCOMA OF NECK

DR. BURTON J. LEE presented a man, now forty-two years of age, who was first seen in November, 1921. He had presented himself for treatment at the Massachusetts General Hospital in 1911, complaining of a lump, which had been present in the left side of the neck for five years.

His physical examination, at that time, presented nothing unusual, except for the local condition, which was reported as follows: "On the left side of the neck, under the sterno-mastoid muscle, is a tumor the size of a halved orange. This tumor is hard, non-fluctuant, firmly attached to the underlying tissue, and raises with deglutition." He was operated upon November 6, 1911, by Dr. Jason Mixer, of Boston, the operation being an excision of the mass. The tumor was dissected free from the carotid artery and thyroid gland. The jugular vein was cut and ligated, the submaxillary space was cleaned free of all glands as far as the parotid. Malignant tissue was found to infiltrate the muscle and the glands of the neck and to extend along the side of the trachea and the inner surface of the thyroid gland. A small part of the tumor could not be removed from the posterior surface of the thyroid.

A pathological report by Doctor Whitney was as follows: "A large tumor from the neck infiltrating behind the thyroid gland lying against the trachea. On section it was firm and fibrous. On microscopical examination it was found to be composed of interlacing bundles of round spindle cells, with marked tendency to the formation of connective tissue. Fibro-sarcoma." The patient was discharged November 15, 1911, in good physical condition.

Nine years later there was a recurrence of the tumor in the left supra-clavicular fossa. This had been present for one year when the patient was first seen in October, 1921. He reported that for two months there had been slight pain in both sides of the neck and there was some interference with breathing, especially at night and on exertion.

Examination, at this time, revealed a mass about 4 centimetres in diameter, low in the left side of the neck, extending to the midline, adherent to the thyroid cartilage and disappearing behind the clavicle. The skin was not adherent to it and the mass itself seemed attached to the deeper structures.

The treatment of this patient consisted, first, of application of a radium pack over the tumor of the neck, giving a dose of 81.45 millicurie hours at a distance of 6 centimetres with filtration of 2 millimetres of brass. Five days later under novocaine anæsthesia, the lesion was excised. It was well encapsulated, except at the lower pole, where it dipped into the thorax; here it tapered into a thin cord. This was divided and 14 glass tubes of radium emanation, a total of 19.8 millicuries, were buried in this area, and the remainder of the operative field. Post-operative convalescence was uneventful and the patient was discharged from the hospital ten days later.

There was no pathological report upon the second specimen removed.

The patient has remained well without evidence of recurrence after six years and two months.

## MELANOMA OF BUTTOCK

DR. BURTON J. LEE presented a woman, who, at the time of her admission to the New York Hospital, in May, 1925, was forty-two years of age. She stated that, for many years, she had noticed a pigmented area in the

middle of the left buttock. About one month previous to admission, she was aware of an increase in the size of the lesion and slight tenderness had developed.

Examination revealed a robust woman, normal, except for the local condition. In the middle of the left buttock there was a pigmented lesion in the skin 1.5 centimetres in diameter and 0.5 centimetres thick. It was light brown in color. There was no ulceration in or about the lesion, nor could any induration or extension be palpated.

At operation, a wide ellipse of the skin surrounding the lesion and underlying fat, measuring  $7 \times 4 \times 3$  centimetres, was removed. Great care was taken to prevent any traumatization of the lesion during excision. Convalescence was uneventful, except for a left femoral phlebitis.

The specimen removed was reported upon by Doctor Beattie.

"Specimen consists of elliptical-shaped piece of skin and underlying tissue measuring  $7 \times 4 \times 3$  cm. Skin white, smooth and hairless. At mid-point of skin is a circular, firm, brownish elevation 1.5 cm. in diameter, 5 mm. thick. This pigmented portion extends through all layers of skin but apparently does not involve subcutaneous fat. Subcutaneous fat is glistening yellow and divided into lobules by fibrous connective tissue.

"Microscopic examination of frozen section shows a tumor composed of spindle-shaped cells some of which contain a great deal of brownish pigment. These cells have large oval nuclei, rather uniform, and appear to infiltrate at edges of growth. In some parts the pigment is very dense, obscuring the cells. Toward the skin surface there is more fibrosis and the pigment is confined to small nests. The most cellular part of the tumor appears to be in the lower layers of the skin connected with the fatty subcutaneous tissue. Paraffin sections will be prepared and an attempt to determine whether the tumor should be regarded as a simple melanoma or a melanosarcoma."

Subsequent pathological report, following the study of the paraffin section, was as follows:

"Paraffin in sections show that the tumor is very cellular, the cells show great variety in size and shape and appear to infiltrate the surrounding fatty and fibrous connective tissue. This picture is suggestive that the tumor has malignant properties."

This patient was presented as a case of melanoma, well, two years and eight months after operation.

DR. CHARLES E. FARR reported a case of a woman, forty-five years of age, who in 1923, came to him for treatment for a freely movable tumor of the scalp of many years' standing. He did a local excision under local anaesthesia and followed this by X-ray treatment to the scalp and neck. This was found to be a melanoma,  $5 \times 4 \times 2$  cm. A year later she came back with a lump in the right side of the neck which she said had been present at the time of operation but which Doctor Farr had not noted, although he had made a careful examination. The lump was removed in the same manner as the previous tumor and was pronounced by the pathologist to be a sarcoma. She went on for a year and in May, 1925, just two years after the first operation, she came back with a mass in the skin of the right flank. This disappeared under X-ray therapy and she stayed well; seen in July of 1926 she seemed to be in good condition. In October, 1926, she had three metastatic deposits in the skin of the neck, the shoulder and the buttock.

A little later many lumps appeared, but the general health was excellent. Under X-ray treatment all the lumps disappeared. In May, 1927, she appeared again with a huge nodular mass in the liver and many nodes in the skin. She felt weak and nauseated, but was able to continue her work as a secretary until August, 1927, and died in September, with enormous masses in the liver, though appearing to be still in fairly good condition. These melanomas are remarkable cases and it seems impossible to predict the outcome. Some of them die quickly, but some of them live on for a number of years.

DR. WALTON MARTIN referred to a case in which the patient, a young girl aged sixteen, had had a pigmented mole removed from the heel by Dr. Charles Peck. Some months later she came under the care of Dr. W. A. Downes. At that time she had a mass as large as a fist in the groin. Doctor Downes excised this mass, which was made up of enlarged, deeply pigmented inguinal lymph-nodes. Sections examined under the microscope showed a structure resembling that of the malignant tumors derived from cutaneous moles.

DOCTOR DOWNES referred the patient to Doctor Martin for observation during his absence. A rapidly growing, dark colored nodule appeared in the skin of the back about six months after the removal of the inguinal nodes. It was excised and sections of the growth presented under the microscope an appearance similar to sections of the mass in the groin, of a rapidly growing melanosarcoma. Subsequently she was given extensive X-ray treatment under the supervision of Doctor Wood. About three years later she married. She had had two children and is living and well to-day, nine years after the last metastatic growth was removed from the back.

DR. HOWARD LILIENTHAL said that it was encouraging to see this result in Doctor Lee's case and even more so to hear of Doctor Martin's patient, alive after nine years, and to learn that these cases, usually regarded as invariably fatal, do sometimes get well. The first personal experience the speaker had had with this disease was with a medical man who had a pigmented mole removed from the axillary region, got prompt recurrence and metastases and died. Then he was called by Dr. Samuel Bandler to see a woman three years after he had operated on her for a small melanosarcoma. He had left a three-inch margin, removing the mole and its entire neighborhood; much as Doctor Lee described was done in his case. When Doctor Lilienthal saw her three years afterward she was dying, with enormous metastases in the liver. The speaker expressed a desire to know what Doctor Lee thinks about the right form of treatment in cases of this kind. Should they be operated on by the usual surgical method, with or without pre-operative radium pack or X-ray, or be operated on by some other method, such as using a cautery instead of a knife as Bloodgood advocates, or by excision with an electric diathermy knife. There should be some standard of treatment for these melanomas.

DR. DEWITT STETTEN said that he would strongly advise against electro-coagulation for the removal of pigmented moles. He spoke with feeling

as he had had an unfortunate experience with a pigmented mole of the breast which had been destroyed by electro-coagulation about three and a half years previous to the appearance of a dark bluish nodule in the neck, that looked like a thrombus in the external jugular vein. This nodule was excised for diagnostic purposes. It lay external to the vein and was found to be a melanocarcinoma. In this connection Doctor Stetten commented on the variations in the biology of these tumors and particularly on the unusual lapse of time of three and a half years, in his case, between the original disturbance and the development of the melanocarcinoma. Doctor Stetten's patient subsequently developed a generalized subcutaneous melanocarcinomatosis, and died in about six months of symptoms of cerebral metastases.

DR. EDWIN BEER said there was no doubt that these melanotic neoplasms varied greatly in their malignancy, which probably accounted for the varying results obtained on different cases. A striking illustration of this was the report of a melanosarcoma of the left eye (published by S. Olbert). Olbert found at autopsy, twenty-four years after removal of the eye, metastasis of the melanosarcoma in the lungs, heart, liver and bones.

#### POST-PNEUMONIC LUNG ABSCESS RUPTURING INTO THE PLEURA

DR. HOWARD LILIENTHAL presented a young woman and gave the following history of the case:

On March 13, 1921, he was called to see a woman, age about thirty, who had developed a right empyema with great distress in breathing and high fever about two weeks after the beginning of a right-sided pneumonia. A diagnostic aspiration produced opalescent pus. The same night, as an emergency procedure, he made a puncture with trocar and cannula, using the air replacement method. This is preferable, in acute pneumonic cases, to the valve tube or the water-seal, both of which tend to expand a lung which may still be infiltrated and not ready to function. Fifty-nine ounces were removed followed by much relief. A few days later two fluid levels were observed in the chest on X-ray examination. The left chest was normal.

A small intercostal thoracotomy was then done in local anæsthesia incising in the eighth interspace. Considerable pus was evacuated much thicker in consistency than before. Drainage by three tubes.

March 27, after a temporary relief and then a gradual rise in temperature to 103, fluoroscopy revealed movable lung, but there was an abnormal shadow below and a small pneumothorax in the lower inner part of the right chest.

Realizing that the case was not an uncomplicated empyema, he then performed a major intercostal thoracotomy, under nitrous oxide and oxygen. A long seventh interspace incision was made, resecting the eighth rib. The rib spreader made full ocular exploration feasible. The upper and middle lobes were not adherent, but were covered with confining membrane. The lower lobe presented an interesting picture. It was contracted and hard and there was a small opening upon its phrenic surface, where pus exuded from a pulmonary abscess of small size. Dense adhesions divided the chest into several distinct cavities. The entire lung was mobilized by peeling away the confining membrane and breaking up the adhesions. It was then possible by insufflation to expand the upper and middle lobes fully while the lower lobe showed but limited expansion. Pericostal stitches and a few sutures in the



## LUNG SUPPURATION—METHODS OF TREATMENT

muscle layers closed the wound except for drainage space for several tubes. Only a little of the skin wound was sutured. Because of the presence of the lung abscess he could not sterilize the pleural cavity by the Carrel method and healing took place rather slowly but completely more than two and a half months later.

The patient has been well ever since, now nearly seven years. The case is presented, because it demonstrates so well the production of empyema by the rupture of a small peripheral abscess of the lung and also to illustrate the rational method of treating such conditions. He was convinced that if he had been satisfied with mere drainage, without exploration and mobilization, a chronic empyema would have resulted and probably broncho-pleural fistula at the site of the lung abscess. It is cases of this kind in which procrastination is to blame for long drawn out illness which may require many dangerous operations for its final cure.

## LUNG SUPPURATION—METHODS OF TREATMENT

DR. CARL EGGERS read a paper with the above title, for which see page 485.

In connection with this paper he presented three patients whose histories are as follows:

CASE I.—R. G., forty-two years old, was seen December 4, 1926, complaining of pain in the right chest, cough and expectoration. He gave the following history:

He had not been well all year and had looked and felt run down. He had also lost a little weight; no other symptoms; no cough, no expectoration, no night sweats.

About the middle of September, 1926, he contracted a cold for which on September 29, 1926, he consulted a physician who diagnosed influenza pneumonia. He was sent to a hospital where he remained six weeks. During all this time he had cough and expectoration, sometimes more, then again less, and his fever varied from almost normal to 103. At first his sputum had a very disagreeable odor, later less so. He did not expectorate blood. Weight and strength gradually diminished. He finally was taken home in a very much weakened condition and continued under the care of his physician with the tentative diagnosis of unresolved pneumonia. November 25, he developed fever to 104, accompanied by an especially large amount of sputum with a little blood, but not of a particularly offensive odor. About that time it appeared to his physician that the physical signs in the chest were beginning to change, and that there were signs of cavitation over the area of consolidation. The patient continued to run fever and had lost in all about thirty pounds since the summer.

At present his chief complaint was: Cough and expectoration, and loss of strength. No night sweats. No pain. No symptoms in relation to other organs. The past history and family history had no relation to his present illness. There was no tuberculosis in the family.

He was a frail man of ninety-eight pounds, who looked as if he had lost weight. His cheeks were flushed. He coughed a great deal and expectorated pus with a disagreeable odor. General examination showed nothing of importance, except moderate clubbing of the fingers. The pulse varied from 96-106. Temperature was 102.2. Examination of the chest revealed the following:

Anteriorly: Expansion equal both sides. Physical signs equal and normal both sides.

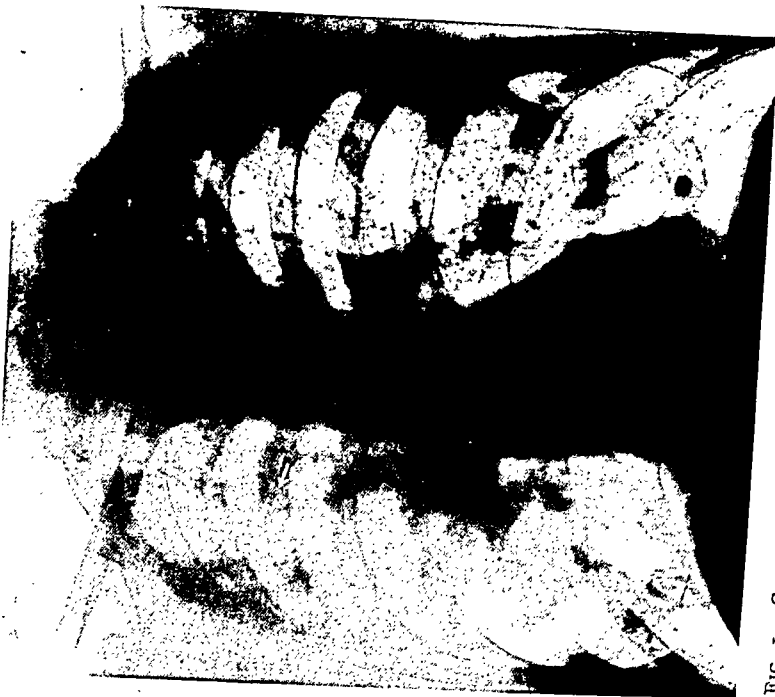


FIG. 1.—Case I. Acute post pneumonic lung abscess of right upper lobe.



FIG. 2.—Case I. Six weeks after operation, showing clearing of lung, and drainage tube still in place. Patient healed soon after and has remained well. Opposite lung shows retained lipiodol.

## LUNG SUPPURATION—METHODS OF TREATMENT

Posteriorly: Expansion about same both sides. There is dulness bordering on flatness on the right side, beginning about one finger above the level of the crest of the scapula and extending downward to about two fingers above the level of the tip of the scapula. Below this level there is diminished resonance while at the apex it seems to be normal. Over the area of dulness and extending forward into the posterior part of the axilla there is bronchial breathing which at times seems to be cavernous. Signs change frequently.

The impression was that they were dealing with an abscess of the upper part of the lower lobe.

Further observation showed that he expectorated about 500 c.c. of foul sputum a day which contained non-hæmolytic streptococcus, pneumococcus, and micrococcus catarrhalis. Repeated examinations for tuberculosis and elastic fibres were negative.

X-ray examination revealed a dense shadow in the right upper chest containing a large cavity with fluid level. (Fig. 1.) A bronchoscopy by Doctor Kernan verified this finding. Pus was seen to flow from the upper lobe bronchus, which on culture showed short chain non-hæmolytic streptococcus, pneumococci, micrococcus catarrhalis and an anaërobic Gram-negative bacillus, type undetermined. An injection with lipiodol did not enter the abscess cavity.

December 21, 1926, an exploratory puncture was done in the sixth interspace posteriorly and thick foul-smelling pus obtained which on smear showed short chain streptococcus, pneumococci and a few fusiform bacilli. On culture only pneumococci grew, but an anaërobic culture showed some spirochaetes and an occasional fusiform bacillus.

He was operated on December 22, 1926, under local anaesthesia: Vertical incision parallel to the posterior border of the scapula, and about  $1\frac{1}{2}$  inch within its border, extending over the sixth, seventh and eighth ribs. The seventh rib was exposed and about two inches resected subperiosteally. Exploratory punctures through the bed of the rib showed foul-smelling hemorrhagic fluid one place, and thick foul-smelling pus another place, after entering through a very dense layer of tissue. The lung was apparently firmly adherent. An incision was therefore made alongside the needle and an intrapulmonary cavity was entered. At first there was but little pus, but when a finger was inserted and the patient coughed, there was expulsion of pus and necrotic lung tissue, while the patient expectorated the same material. He was quite upset but his condition remained good. There was apparently extensive bronchial communication. Moderate bleeding. A large iodoform gauze tampon was packed into the cavity and another tampon was packed around it to keep the outer wound open and prevent absorption. No sutures were placed. He had stood the operation quite well.

The convalescence was uneventful. The sputum diminished in amount and changed in quality, the temperature gradually came down and his weight began to increase. The superficial tampon was removed on the sixth day, and the deep one on the eighth day, and was replaced by three soft rubber tubes. The cavity, which at first was about the size of a goose egg, gradually contracted. The patient was allowed out of bed eight days after operation and was discharged January 22, 1927, just a month after operation, and with a gain in weight of eighteen pounds. He was allowed to close soon after and has remained well. His lungs are clear. (Fig. 2.)

CASE II.—J. C., fifty-six years old, first seen May 17, 1927, complaining of cough, expectoration and hæmoptysis. His present illness dated back to

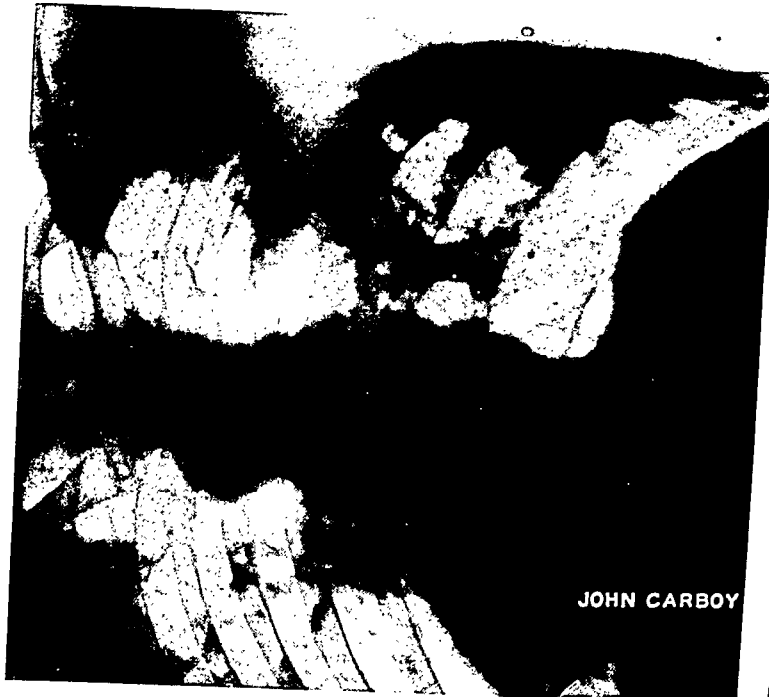


FIG. 3.—Case II. Chronic lung abscess, access to which was difficult on account of its posterior position, under the scapula.



FIG. 4.—Case II. Nine months after drainage operation through a high axillary approach. Bronchial fistula being kept open at present.

March, 1926, when he began to have cough and expectoration of foul pus. He stated he had had no fever, but frequently had cold sweats. Cough and expectoration would let up for a while and then return for one to three weeks, when another period of rest would set in. During attacks the sputum always tasted and smelled very disagreeably. He thinks some days he raised as much as a quart, though he never actually measured it. He had lost about ten pounds in weight. In January, 1927, he began to have frequently recurring small hemorrhages, usually about half a cup full, though on one occasion there was a large quantity. He is able to feel filling up of a cavity within his chest, when full, he is very uncomfortable, and pain develops in the front of the right chest, near the nipple. When empty he has no pain. He had been on bronchoscopic treatment since January, 1927, and thought that it had helped him much.

For about ten years he had been troubled with coughing and sneezing, but he never had a severe attack of an intrathoracic condition until four years ago when he had an attack of what he calls pneumonia. It confined him for nine months. Toward the end of the convalescent period he had a severe coughing spell one night and expectorated a 1¼-inch nail. There was no bad odor or taste at that time, however. He is a latherer by trade and holds nails in his mouth while at work and frequently swallows one. He thinks one of these nails may have entered his lung and produced the pneumonia and the subsequent abscess.

On admission the patient did not look particularly sick. His temperature ranged from 100–101. He weighed 172 pounds. He expectorated 250 to 400 c.c. of foul sputum in twenty-four hours. During several weeks of observation he had a number of hemorrhages, his temperature showed a tendency to rise to 102, and over, and he lost weight.

The sputum showed on culture staphylococcus albus, non-hæmolytic streptococcus, pneumococcus and micrococcus siccus. Numerous specimens were negative for tuberculosis.

X-ray examination revealed a dense shadow in the right side with cavity formation and a fluid level. (Fig. 3.) It was situated under the scapula, and seemed to be very inaccessible. But as operation seemed to be the only way to save this patient, it was decided on.

Operation June 6, 1927, under local anæsthesia, a four-inch incision was made high up in the axilla, parallel to and just below the border of the pectoralis major. Muscle retracted upward and ribs exposed. About two inches of the fifth rib were resected. Underlying pleura was found to be thickened. Exploratory puncture showed thick foul pus at depth of 2 inches. With an electric cautery the cavity was entered alongside the needle, and the opening was then enlarged with a finger. The cavity was about the size of a walnut, had a fairly smooth lining, and in addition to pus contained necrotic lung tissue. There was brisk bleeding and the patient expectorated a small amount of blood. It was controlled by gauze pressure. An iodoform gauze tampon was inserted into the cavity, surrounded by a superficial plain gauze tampon. The patient stood the operation well, and the convalescence was satisfactory except for the fact that there was a great tendency for the fistula to contract. He was discharged August 4, 1927, and treatment was continued, but in spite of all precautions the wound contracted to such a degree that retention developed, which was again accompanied by rather severe hemorrhages, both from the wound and *via* the bronchi.

He was therefore readmitted for operation; which was performed October 25, 1927. Under local anæsthesia the sinus tract was completely excised and



FIG. 5.—Case III. Chronic bronchiectatic abscess of four years' duration.

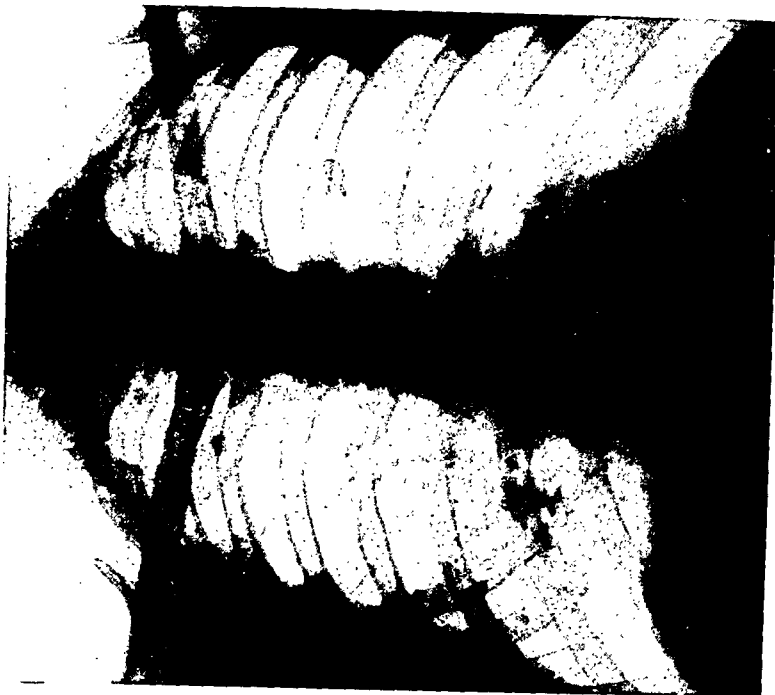


FIG. 6.—Case III. Eight months after drainage operation through bed of fourth rib anteriorly. Bronchial fistula persists, but gives off only a little mucus secretion. Patient well and strong.

the ends of the formerly resected rib were removed in normal tissue. For better exposure the rib above was likewise removed and the pleura then mobilized over a wide area. The rigid ring contracting the opening into the cavity was incised and dilated with the finger and the abscess cavity cleaned out. This entire procedure had mobilized the affected lung tissue somewhat and promised to favor healing. A large soft rubber tube was inserted and the wound left wide open. The patient did very well, cough and discharge diminished, but severe hemorrhage continued until on November 15, the cavity was burned out with a hot soldering iron. From that time until to-day there has been no further bleeding and the general condition has steadily improved. The X-ray shows clearing of the lung and the prognosis for a permanent cure is good. (Fig. 2.)

CASE III.—G. K., first came under the reporter's care, February, 1924, for an old suppurative lesion of the chest dating back five years. It had started insidiously in August, 1919, apparently with a pleurisy. This was tapped twice. During the convalescent period he began to cough and pneumonia was diagnosed, for which he was admitted to the Lenox Hill Hospital. An examination at that time showed an area of dullness corresponding roughly to the middle lobe. He expectorated 120 c.c. of foul sputum daily. His temperature did not rise above 100. He had 17,450 white blood-cells with 78 per cent. polymorphonuclears. A diagnosis of lung abscess was made which was verified by X-ray and bronchoscopy. The sputum was negative for tuberculosis. There were no elastic fibres present. As there was slow, but steady improvement, he was discharged October 12, 1919, with instructions to remain under the care of the bronchoscopic department. During the next few years he had periods of comparative well being alternating with periods of acute exacerbation of the lung focus. He was bronchoscoped many times with improvement, but no cure resulted. X-rays taken from time to time show the process never entirely cleared up. When first seen by the reporter he had not been bronchoscoped for five months. He stated that he had had no foul expectoration since that time, but that he had a pulmonary hemorrhage every three or four weeks, coughing up 50 to 100 c.c. of clotted blood each time. The day before admission he had a severe one. The hemorrhages were often followed by nausea and vomiting. The X-ray examination showed a small cavity within an area of density situated anteriorly in the right chest. (Fig. 5.)

February 11, 1924, operation, first stage, local anæsthesia.

The entire cartilage of the fourth rib, and a small section of the rib were resected. The internal mammary vessels were ligated, and the thoracic fascia divided, exposing lung and pericardium. There were apparently no adhesions. Operation therefore interrupted and tampon inserted. Though the intervention was slight, the patient developed a post-operative pneumonia on the opposite base. After recovery the second stage was performed.

February 23, 1924. Tampon removed. Additional two inches of the fourth rib and a section of the fifth rib with its cartilage were removed. Exploratory puncture showed thick pus. With a cautery a hole was burned into the lung down into the cavity, which was the size of a walnut and had hard trabeculated walls. There was brisk bleeding which could be controlled only by hæmostatic sutures. Several bronchial openings were present. The cavity was left open and has resulted in a bronchial fistula which is still present, but which gives off practically no secretion, and is ready to be closed. After operation hemorrhages ceased entirely and the patient has remained well and strong. The lung infiltration has cleared up completely. (Fig. 6.)

DR. WILLY MEYER said regarding the place of bronchoscopy in the treatment of lung suppuration, at the Lenox Hill Hospital, if these thoracic patients do not require immediate surgery, they are referred to the bronchoscopical department.

Early, better called prophylactic treatment, is of particular importance in suppurative inflammation due to aspiration. By means of endobronchial treatment the further development of the disease can be cut short. Long-continued treatment carefully carried out by specialists has shown what can be accomplished. In these border line cases bacteriologist, radiographist, bronchoscopist, and surgeon must work hand in hand together. The bronchoscopist will not keep these cases too long; if not satisfied with his results, he will refer the proper cases back to the surgeon.

Second: As to abscess near the division of the main bronchi, at the root of the lung. These cases are particularly favorable to bronchoscopy and may thus be cured. But if they need surgical treatment, he would call attention again to the method proposed by Sauerbruch two years ago, continuous compression. He exposed the pleura widely, dividing, but not excising the muscles, put on the pleural surface a layer of paraffin, and sutured muscles and skin. The extensive continuous pressure, thus exerted, cured the trouble in some cases. In others fever developed and the pus perforated into the area where the paraffin had been deposited. By partially reopening the wound, pus and paraffin were discharged. Of ten such cases ten were cured. After bronchoscopy has failed to cure these cases, this conservative operation deserves attention.

DOCTOR LILIENTHAL remarked that the last one shown was a perfect example of lattice lung, one of the most difficult conditions to cure. The speaker did not believe it could be closed except by covering in the cavity from the outside. This would by no means promise a good result. It should not be forgotten that in all these cases the principal danger is that of hemorrhage; even after years have elapsed they are apt to bleed. The last case of lattice lung in Doctor Lilienthal's experience developed a malignant growth, and at the present time he has a case under his care that is giving him anxiety. The patient is a woman on whom he operated for lung abscess. His operation—drainage—stopped profuse expectoration and cough but she now has an open cavity like that of the patient shown to-night. Trying to snip off a small cone to get a specimen of the wall started a furious arterial hemorrhage which led to the belief that there are aneurysmoid vessels there which forbid any procedure except, perhaps, a cautery operation. He has two patients in this class who have healed up perfectly and seem to be absolutely well. One, a young man, was having a severe hemorrhage, and the speaker was called from a distance to stop this, which he did by wide thoracotomy, exposing the vessel and putting a stitch around it. The man got well and the cavity lined by lattice lung completely closed. He came in recently to be looked over because of another ailment and a röntgenogram revealed a considerable cavity perfectly circular. So far as his lung symptoms go,



he is well and has no cough. This condition might be brought about in Doctor Egger's case by roofing over the abscess.

DOCTOR LILIENTHAL noted that Doctor Eggers had made no attempt to standardize operations on the lung. Trying to do that will not only tend to put a stop to original work, but will encourage operations by wrongly selected methods. The only point in which the speaker differs with Doctor Eggers is in the manner of operating in cases of pure lung abscess not connected with the bronchus. Doctor Lilienthal considered it unfortunate if the abscess connects with a bronchus because it means a fistula, more or less persistent. If one can get into the abscess before it connects with a bronchus the tendency is for the wound to close, since every cough or strain forces the walls of the cavity together, while with a bronchial fistula the walls are blown apart.

As to Doctor Eggers' comment that many of these cases have an insidious onset, that has also been Doctor Lilienthal's experience. The first sign of trouble may be putridity of the breath and then the case is usually pretty far advanced. It is important that medical men be educated to have X-ray pictures made of the chest in unexplainable cases of malaise and continued fever, even though there be no cough.

DR. DEWITT STETTEN said he would like some suggestions as to the best plan of procedure in acute cases where one cannot wait and where operation becomes imperative. A little over a year ago he saw a case with an acute abscess in the upper lobe of the right lung. The patient did not tolerate bronchoscopy and became so sick that operation was practically forced. On probatory puncture of the chest air was withdrawn, showing that there had been a perforation, and that a beginning pyopneumothorax existed. An attempt was made to enter the chest over the abscess, but unfortunately the lung was not adherent to the chest wall, as was to be expected from the air in the pleural cavity, so that the operation was done through the free pleural cavity. The abscess was readily found and drained. The patient died within twenty-four hours. In these cases one seems to be placed between Scylla and Charybdis, the patients die if one operates, and they also die if one does not operate.

DOCTOR EGGERS, in closing the discussion, emphasized the importance of knowing what one has in mind when speaking of the treatment of lung abscesses. One has to have a mental picture of the probable pathological process, and one has to consider the time since onset of the condition. There is a great difference between acute and chronic cases. In the case referred to by Doctor Stetten, with a well-defined cavity and fluid level, an operation done in two stages might have brought about a cure. Such cases usually do quite well; as a matter of fact they are the most favorable ones for surgical treatment. If on the other hand, perforation into the free pleura had taken place before operation, at once infecting the entire pleural cavity, the prognosis was thereby made much worse, because the resulting condition resembled a traumatic empyema. Drainage of the empyema would then have

been the proper procedure. It cannot be denied, however, that many of these acute cases are doomed to die in spite of all that is done for them. Some of the gangrenous abscesses have aspirated putrefactive material, and they contain spirochaetes. They are probably given the best chance with conservative treatment in an attempt to bridge over the acutely septic stage.

DR. HUGH AUCHINCLOSS said that one of Doctor Eggers' cases recalled to his mind two somewhat unusual cases of lung suppuration. Both had closed to a small bronchial fistula that it seemed wise not to close. One was a child who had a story of having been operated on for an empyema every fall for the first three years of his life—three empyemata in three years. In the fourth year this occurred again. Doctor Auchincloss saw him then and operated on him. The following year the same thing happened. Doctor Auchincloss operated again and found a pleuro-pulmonary type of abscess with a well-defined bronchial fistula. Two ribs and some of the chest wall were removed. The wound did well, closing almost completely, save for a small bronchial fistula. This tiny opening has been allowed to persist. He has remained well and spends every winter in the south. If he gets a cold the bronchial fistula pours out pus. The other case is that of a woman in her thirties who had a lung abscess in the left upper lobe following tonsillectomy. Though studied and treated at length at Saranac, it became progressively worse. Rib resection and cauterization of the lung was done and she did well. A very small bronchial fistula persisted. Whenever there is coughing pus pours out. One should not overlook the value of a bronchial fistula as a safety valve.

DOCTOR AUCHINCLOSS wished to call attention to the danger in opening lung abscesses with open bronchi in their walls when the patient is under general anæsthesia and resting on the well side. Lipiodol injections have fully demonstrated the readiness with which the injected substance passes from one bronchus to another by postural change only. Mucus is tenacious and flows with difficulty, but many lung abscesses contain pus that is fluid in consistency and contains relatively little mucus. That this material may gravitate into the bronchi of the well lung has long been recognized and undoubtedly occurs. Many patients seem to be able to stand this, however, especially if the operating table has the head lowered or raised, the former to allow pus to run out the mouth, the latter (in lower lobe cases) to leave it undisturbed. What happens, on the other hand, the moment the cavity is opened, is a somewhat different matter. It is precisely at that time that many such cases have suddenly changed for the worse, and every once in a while have died. As the chest wall is lifted out in inspiration before opening the cavity air is pulled through the glottis and distributed everywhere in such measure as conditions permit. The cavity is but little affected and its fluid contents do not leave it. The instant the cavity is opened through the chest wall, however, a new route for air to be carried to the lungs, a new "glottis" has been established and with every inspiratory effort the purulent contents of the cavity are atomized, as it were, to all parts of the lungs along

with the air. If the cavity contents be not immediately removed, or the rush of air through the hole in the chest checked, or the aspirated material coughed up and cleared out by the doctor's or the patient's own efforts, either immediate suffocation or widespread bronchial diffusion of the infection occurs. Of course there is nothing new in stating these facts, but it is still worth emphasis so that adequate precaution may be taken for prevention. When in doubt it is far safer to locate the cavity as accurately as possible, resect one or more ribs as the case may require, then pin small safety pins attached to gauze directly into the tissues by bed of the rib, in different parts of the wound's depth as close to the lung as possible and leave open, using rubber dam with gauze packed into it. Subsequent X-rays can be taken or fluoroscopy done and the cavity opened at its most approachable place, using the safety pins as markers. This can be done often without even an anæsthetic and the patient sitting up and in control of his reflexes. The risks incidental to needling and opening lung abscesses with open bronchi in their walls requires periodic and earnest emphasis, for they are genuine. Irreparable damage may occur in the twinkle of an eye in these procedures and the risk become apparent too late in the desire to "complete the job" all at one time.

## BRIEF COMMUNICATIONS

### NONMALIGNANT PAPILLOMA OF THE UMBILICUS

Recently a colleague, referred a man fifty-seven years of age, on account of a supposed cancer growth of the umbilicus. My surprise centred itself on the part of the patient's anatomy involved, the umbilicus. I remembered only faintly having read of growths, malignant and benign, of the umbilicus, but had seen none. Interest became more acute when I recalled former years of active service with a Railroad System where physical examinations and close inspections of the body were routine measures. In this service I had occasion to see some fifteen thousand navels. I fail to recall a single

instance of a pathologic condition suggestive of a growth, benign or malignant. The abnormal conditions encountered were usually hernias and infections caused by filth.

In my service of eighteen years at a City Hospital, an institution of 800 beds, where abdominal examinations were frequent, I cannot recall a single case of a growth involving the umbilicus.



FIG. 1.—Papilloma of the umbilicus.

The acquisition of this one case has served as a sharp stimulant to augment my knowledge and this I succeeded in doing by perusing Cullen's "The Umbilicus and its Diseases." In this work there can be found much of the scattered knowledge about the umbilicus and its diseases. This can be readily appreciated by the student in search for information pertaining to lesions of the umbilicus, inasmuch as the literature appears to be rather scant.

Perhaps the most extended contributions on umbilicus diseases have been made by Nicaise in 1881, by Reginald Fitz, of Boston, in 1884, by Pernice, who expressed his views on umbilical tumors in 1892, and by Runge who wrote on umbilical infections in 1893. In 1911, there appeared an article on "Surgical Diseases of the Umbilicus" in the *Journal of the American Medical Association* by Dr. Thos. S. Cullen.

It may be of interest to note that there are only eleven cases of papilloma of the umbilicus chronicled in the work of Cullen obtainable from the literature. The first case recorded was seen by Fabricius von Hilden, in 1526, and cited by Küster in Langenbeck's *Archiv. f. klin. Chir.*, 1874. The last case in the series was a patient of Dr. W. T. Watson and was reported in 1910, "personal observations by Dr. Thos. S. Cullen."

In the case now reported, a man, fifty-seven years of age, the health

had been good and his physical condition excellent. He stated that the first intimation of anything wrong with his navel was an itching, which was somewhat relieved by his morning bath. An ointment prescribed by his physician gave considerable relief. During the next four weeks, although the itching had almost subsided, the condition of the navel did not seem to have improved. There appeared a soft reddish mass which involved the navel. This mass extended beyond the skin level and was not painful. It continued to grow rapidly and bled freely during the following two weeks, when removal was advised. On examination it was found that the umbilical depression was filled with a warty protruding mass (Fig. 1) covered with an elongated papillary growth, the whole resembling in shape and appearance a large raspberry. The tumor appeared free from discharge. There was no odor and the color was pinkish. The abdominal wall surrounding the papillary growth was normal and free from irritation. Upon close inspection it was found that these papillary masses were attached to a broad pedunculated base at the bottom of the umbilical pocket.

On microscopic examination, made by Doctor Klenk, the growth was found to be a papilloma and not malignant. Even though the microscopic examination excluded malignancy, it was excised with a liberal sacrifice of healthy tissue.

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## CHRONIC PANCREATITIS IN ROUTINE NECROPSY EXAMINATION\*

Clinically chronic pancreatitis is associated with upper abdominal pathological lesions. It is generally assumed to be a sequela of gall-bladder infection and ulcers of the stomach and duodenum. When one follows cases of gall-bladder disease which have been submitted to operation, either for simple cholecystitis, or cholecystitis and cholelithiasis, one cannot help but be impressed with the number of cases which complain of abdominal discomfort. The complaints are more or less characteristic of the original pain, and the attacks may simulate those of cholelithiasis. Attacks of severe abdominal pain are encountered in post-operative cases of chronic cholecystitis. One is hardly justified in trying to explain these recurrent attacks as overlooked biliary calculi. Judd and Burden<sup>2</sup> have reported a series of twenty-four cases of non-calculous intermittent biliary obstruction following cholecystectomy in which the findings after an exploratory laparotomy were pancreatitis in seventeen cases out of twenty-four, the common duct being patent in all. Deaver reported seventy-nine patients with chronic pancreatitis at the Lankenau Hospital, of which 72 or 91 per cent. showed evidence of biliary infection. Forty-two cases, or 53 per cent., had calculi. W. J. Mayo<sup>3</sup> reported that 90 per cent. of the cases having acute and chronic pancreatitis had been

\* The pathological studies were made by Dr. Paul Klemperer, formerly Associate Professor of Pathology at Post-Graduate Hospital, and now Pathologist at Mt. Sinai Hospital; and Dr. Boris Kwartin, Associate in Pathology at Post-Graduate Hospital.

operated on for an infected gall-bladder, usually with gall-stones. Whether chronic pancreatitis is frequently encountered in healthy people is the question prompting this study.

We have studied fifty cases of accidental death and sixteen cases of death from acute abdominal infection, in an effort to determine whether the pancreas was involved in either group. This material has been obtained from the mortuary of Bellevue Hospital, through the courtesy of Dr. Charles W. Norris, Chief Medical Examiner of the City of New York; and Dr. Douglas Symmers, Director of Laboratories at Bellevue Hospital.

GROUP I.—This material was obtained from fifty people meeting with accidental death. So far as we know these people were in normal health at the time of their death. Sections were taken from the gall-bladder; two sections from the liver, one from the surface and another from the central portion; a section from the duodenum at the entrance of the common duct; three sections from the pancreas, including one from the head, one from the tail and one from the body. The appendix was also studied. The causes of death in this series included thirty-five from fractured skulls, one from a stab wound of the neck, three from ruptured livers, three from fractures of the pelvis, four from stab wounds of the chest, four from gunshot wounds of the abdomen, with hemorrhage, and one from a rupture of the heart due to a fall. The ages in this series ranged from eighty years to four years, the average age being thirty-seven and seven-tenths years. There were thirty-eight males and twelve females. Of the material studied in this group only two showed a mild chronic cholecystitis. Sections of the liver were negative for a chronic hepatitis, and the three sections from the different portions of the pancreas failed to reveal any evidence of pathology. Sections from the duodenum were negative.

GROUP II.—This series included sixteen people dying from acute peritonitis. There were eight cases of abortion with general peritonitis, two cases of ruptured and duodenal ulcer with peritonitis, one case of ulcerated colitis with peritonitis, two cases of acute appendicitis with general peritonitis, two cases of stab wounds of the abdomen with peritonitis, one case of middle ear infection, meningitis, and general septicæmia, with peritonitis. This group included nine females and seven males, the average age being thirty-one years. The sections taken from the pancreas failed to show any evidence of acute or chronic pancreatitis.

Although a mild degree of chronic cholecystitis was found in two cases of the first group, the pancreas failed to show any evidence of pathological lesions in either group, but as chronic pancreatitis bears a definite relation to upper abdominal infections, this series will only tend to prove that the pancreas is usually not easily infected. Whether chronic pancreatitis is produced through the lymphatic route or by ascending through the pancreatic ducts is still a debated question, but from the clinical evidence the lymphatic theory seems to have more support. It has been our aim to obtain pancreatic tissue from cases of gall-bladder disease which come to autopsy, but we have been

## TRANSVERSE INCISION FOR UNILATERAL HERNIA

unable to get sufficient material to be of any value as yet. By this means we hope to prove whether chronic pancreatitis, as stated by Deaver and Pfeiffer,<sup>1</sup> is localized to the triangle of pancreatic infection between the duodenum and converging ducts of Santorini and Wirsung, or whether it involves the entire gland.

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## TRANSVERSE INCISION FOR UNILATERAL HERNIA

The transverse incision for operation on bilateral inguinal herniæ has been found very satisfactory and has several advantages over the old double oblique incisions. It is now quite generally used.

For unilateral inguinal hernia, a transverse incision, running from middle of Poupart's line to midline of the abdomen, will be found equally suitable and satisfactory. Even femoral herniæ are well exposed with this method. After some experience with this incision, I prefer it to the usual method for several reasons. Excel-



FIG. 1.—Shows transverse incision on right, and usual oblique incision on left.

lent exposure is obtained with a shorter skin wound. The incision is kept away from the groin with its skin folds and loose tissue. There are fewer vessels that require tying. Application of the dressing is easier. The line of suture of superficial fascia does not parallel the cord. The operative field can be much better protected than with an incision running toward the groin.

In cases where it is necessary to do some intra-lower abdominal work, in addition to a hernioplasty, this incision can be lengthened and used as in the Pfannenstiel method. The usual nerve block injection anesthetizes the line of incision.

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## BOOK REVIEW

EXIGENCIES OF A GENERAL PRACTICE. By the late NATHAN CLARK MORSE, M.D. Revised and rewritten by AMOS WATSON COLCORD, M.D. Second edition. St. Louis, The C. V. Mosby Co., 1927.

Ten years after the first appearance of this work, Colcord emulating the monitions of Morse, "Learning to do things better," pays him homage in this revised and rewritten second edition.

What it may lack in effectively coping with exigencies, it makes up in its comprehensiveness, since everything comes in for consideration from adhesive plaster usage to toxicology, always profusely illustrated. It impresses one as an unabridged "First Aid Manual" or "Minor Surgery" in a major key for the use of physicians remote from medical centres, the "die hard" country doctor of the old school.

But rapid means of transportation has taken the "urge" out of emergency and placed the rural surgical and medical clientele on a par with the urban, and surely the exigencies of the great war demonstrated nothing better than that the place to administer effective emergency treatment was at the base. All else was "First Aid," wherefore in conclusion we submit that though replete in what it proffers, the effort that produced this handy reference book was worthy of a better purpose other than the quixotic plan to bring the mountain to Mohammed.

MARTIN W. WARE.

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## THROMBOPHLEBITIS OF THE LOWER EXTREMITIES\*

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ONE can hardly see many patients suffering from ulcers of the leg without being struck by the number of those who present areas of œdema, induration, discoloration and ulceration for which varicose veins of the familiar type are clearly not responsible. Such areas are often extensive, unassociated with trauma and seem to have no adequate cause. They are the source of much pain and disability, particularly in the working classes.

In questioning a considerable group of such patients it will be found that nearly all have suffered at some time from a recognized thrombophlebitis, that is, a "milk leg," or a similar disease occurring in the course of convalescence from an operation or an acute fever such as typhoid or pneumonia. In some instances the connection between the late complication and the thrombosis is very direct and obvious, in others remote and obscure. As a rule, venous stasis, as exhibited by dilated veins or blueness of the extremity, is little marked or altogether absent. On the other hand, the condition which one is accustomed to associate with acute or chronic lymph stasis, that is, porky œdema of the tissues, is almost invariably present. The cause of these late results is perhaps to be found in the nature of the original thrombosis.

The venous thromboses, as one familiarly sees them, appear to be divisible into several categories. The *first*, which has long been known as phlegmasia alba dolens, apparently represents a thrombosis of the principal deep veins of the limb, a thrombosis which may perhaps begin in the pelvis, iliac thrombosis, but which gives the impression in some instances of a considerable involvement of the femoral vein as well. Fever is usually present. The swelling is evenly distributed and may be very tense. The *second*, which may perhaps occur as a complication of the first but which as a rule is an altogether independent process, takes the form of a thrombosis of superficial veins external to the muscular aponeurosis, a disease which is marked by the presence of palpable thrombus formation in the great saphenous system of veins, and, as a rule, by evidence of inflammation about these vessels. Both these types, particularly the second, may be followed, after recovery from the original attack, by a secondary development of œdema, induration and ulceration. The *third*, represents thrombosis in varicose veins. This disease is very common, tends to be recurrent, and causes, compared with the first two, little disturbance outside the immediate vicinity of the thrombosed vessels. There is often

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swelling and redness over the inflamed varicose veins, but the intensity of the process varies widely between individual cases.

Inasmuch as the immediate and remote effects of thrombophlebitis in veins already varicose differ decidedly from the results of thrombosis of the first two classes, that is, where the veins have hitherto been normal it will be convenient to discuss this disease now and to dismiss it from further consideration.

*Thrombophlebitis in Varicose Veins.*—The changes in the vein walls incident to varicosity are primarily responsible for the thrombosis. Trauma and infection are probably exciting causes. More or less of the great saphenous system may be affected, but thrombosis usually begins in the calf or lower thigh and progresses upward. The process, if it reaches the saphenous opening, appears to stop there, for there is rarely any evidence of a disturbance of the deep venous circulation. The course of the disease, though slow, is favorable. Suppuration is rare; the veins are ultimately canalized, never permanently destroyed or obstructed.

Since recovery from the thrombosis brings no relief from the basic varicosity, since the condition itself is disabling and since embolism occasionally occurs, removal of the thrombosed varicose veins, if safe, is clearly indicated. That it is safe and has proved a highly satisfactory procedure is demonstrated by the results of a considerable number of such operations performed at the Peter Bent Brigham Hospital, Boston, during the last fourteen years. It has been the custom to operate as soon as the local inflammatory reaction, if severe, has so far subsided that the infection seems unlikely to be spread by removal of the thrombosed vessels. If necessary, adherent skin is excised with the veins. The operation is begun in the groin at the saphenous opening to obviate the danger of embolism. The immediate and late results have been excellent and though the total number of cases has been too few to enable one to state that the operation may not be a source of embolism, no such accident has occurred. Moreover, the evidence offered by the following case goes to show that the detachment of clots may be a real danger in patients not subjected to operation and is likely to be obviated by removal of the veins:

A young woman suffering from thrombosed varicose veins came to the hospital four months pregnant. She had recently spat up blood on several occasions. X-rays of the chest suggested the possibility of tuberculosis. The thrombosed veins were removed under local anæsthesia without disturbing the pregnancy. Following the operation hæmoptysis ceased, and reëxamination of the chest suggested to the radiologist the presence of healing multiple infarcts.

In thrombosis of veins already varicose there is, as compared with other forms of thrombosis, a remarkable absence of secondary disturbances in the forms of œdema, induration or ulceration of the calf. Apparently, therefore, an antecedent varix offers a certain protection against lymph stasis. Indeed, it may be true that the lymph channels which normally accompany the superficial veins are gradually destroyed early in the course of varix, that new lymph channels become established and that these are not disabled when

thrombosis of the varicose veins occurs, being out of reach of the inflammatory process. This is getting rather ahead of the story of lymphatic obstruction which will come up insistently in the discussion of thrombophlebitis in normal veins.

*Thrombophlebitis of the Deep Veins of the Legs.*—No attempt will be made here to account for the incidence of this disease. Nevertheless, the general swelling of the leg and thigh, even the buttock in some instances, points to a circulatory obstruction within the pelvis, and since a thrombophlebitis during the puerperium (which would be likely to have a uterine origin) cannot be distinguished from any other form of deep thrombophlebitis, it seems probable that phlegmasia alba dolens always arises in the pelvis, involving primarily perhaps, the internal, and secondarily, the common iliac vein. How far peripherally the process extends is very difficult to say. Supposedly collateral vessels may appear upon the upper thigh and even upon the abdominal wall, showing that the upper femoral vein has been at least temporarily obstructed, and I have recently studied a patient in whom, after the swelling in the early course of the disease has subsided, a collateral venous anastomosis about the knee was in evidence, as if the popliteal veins were still plugged. Such a state is perhaps unusual. More often no evidence of venous congestion in the lower leg is present. It is tempting, therefore, to suppose that there are very local thromboses causing a brief and slight disability and extensive thromboses causing a long-lasting disability.

As is well known, a phlegmasia alba dolens is usually ushered in by fever and by pain in the calf, the popliteal space or perhaps the groin. Almost at once the lower leg begins to swell but does not turn blue. Why the absence of blueness? Is it actually present but engulfed in the œdema, or is a collateral venous circulation so readily established that venous congestion of the limb is never a serious feature of the disease? I lean to the latter view. My one experience of dividing a normal femoral vein in the groin showed that the resulting blueness of the leg died out within forty-eight hours, after which neither venous obstruction nor any swelling of the limb was ever noticeable. Moreover, in dogs, division of the femoral vein causes no visible circulatory changes of any sort. It would then seem highly probable that a venous thrombosis, spreading peripherally, leads to so rapid a development of a collateral circulation that blood has no particular difficulty in leaving the leg. Even if such were not the fact, venous obstruction alone would fail altogether to explain the white swelling of a deep thrombosis.

In the course of a day or two following the onset of the disease, swelling is at its height. As a rule the leg and thigh are evenly enlarged. In mild cases the condition persists for a week perhaps, then gradually subsides, so that within two or three weeks from the time of onset the leg has returned to a normal size. Thereafter, some œdema returns as the patient begins to get about, but is never again serious. In a more severe form of the disease, fever and swelling persist with little change for as long as several months. Even then a complete recovery may follow, but, as I shall presently show, after a

prolonged illness of this sort, a disabling complication is likely sooner or later to set in.

The complication to which I have alluded takes the form of a porky œdema in the superficial tissues of the calf, usually on the inner and anterior face but not rarely upon the posterior surface, or low down, upon either side of the ankle. As a rule there is one large area of this sort. (Figs. 1 and



FIG. 1.—M. S. No. 11973, O. D. D. A mild and late œdema and induration with healed ulcer, following a "milk leg," left, six years earlier—presumably iliac and femoral thrombophlebitis. At that time, swelling lasted three to four months. Subsequently, aching discomfort in calf. For two months, noticeable hard lump on inner, lower calf. Ulcer formed and healed under bandaging. Area of induration extends to the back of the calf. Disease stationary under elastic stocking.

2.) Occasionally, scattered lesions, altogether separate from each other, appear. Rarely a broad ring is formed about the leg. This œdema sooner or later becomes indurated, the skin over it pigmented, and if the patient must spend much time in standing, the indurated area finally breaks down wholly or in part and becomes an obstinate ulcer. I previously supposed that such changes appeared only after a superficial thrombophlebitis, that is, of the great saphenous vein. It is true that they are more likely to follow a superficial than a deep thrombosis, but they certainly occur in the absence of any disease of the superficial veins. For want of a better term, I have come to describe these superficial areas as postphlebitic indurations.

If the tissues are incised they give the impression of a rather chronic nonsuppurative infection. The fat is scarred and œdematous, and as the muscular aponeurosis is approached the scar tissue becomes denser. In extreme instances it has something of the appearance of true elephantiasis. Indeed the deep fascia covering the muscle may be one-quarter inch in thickness, remarkably dense and tough. Beneath this level the process no longer appears. The inner surface of the aponeurosis and the delicate reticular tissues beneath it are undisturbed. Such a condition as this may develop a number of years after the original thrombosis or it may appear within a few months. It progresses slowly and steadily or in waves and may lead to a state in which amputation is considered.

## THROMBOPHLEBITIS OF THE LOWER EXTREMITIES

What then is the explanation of the white swelling associated with a deep thrombophlebitis, with its variations in intensity, its tendency to slow recovery and its occasional sequelae? It is difficult to escape the conclusion that a disturbance of the lymphatics is at the bottom of the process. One must suppose that the inflammatory process associated with thrombosis promptly involves the principal lymphatic trunks draining the limb. There is no reason

why it should not do so, since these trunks hug the veins very closely and may even be embedded in the adventitia of their walls. Moreover, the great vessels at the root of the leg and the iliacs as well are closely bound together in a tough fibrous sheath. Sabin<sup>1</sup> has described the origin of the lymph vessels of the legs. They arise in the embryo from primary iliac sacs dorsolateral to the aorta. A common iliac branch divides into two main trunks, an internal and external iliac, or femoral. The latter drains the two sets of lymphatics from the lower limb, the superficial and deep. Reichert<sup>2</sup> states that in animals "most of the superficial lymphatics of the leg and foot, as well as some of the deep lymphatics that drain the muscles of the leg, terminate in the popliteal lymph



FIG. 2.—A. D. No. 78,566, O. D. D. Moderately severe edema and induration of both legs following bilateral "milk leg," most marked on the right, ten years earlier—presumably an iliac and femoral thrombophlebitis. Was laid up for nine weeks, then swelling slowly disappeared. For the last five years pain in calves with edema. For two years ulcer on and off in right leg. The disease is progressing.

gland. From this gland large efferent trunks course along the femoral vessels to end in the external iliac glands just distal to the bifurcation of the aorta. Many of the superficial lymphatics of the thigh and upper leg drain into the inguinal lymph glands, which in turn have efferent vessels terminating in the external iliac glands. The deeper set of lymphatics in the muscle sheaths of the thigh eventually enter trunks that accompany the main femoral lymphatics and drain into the large iliac glands." Thus it is inevitable that a lesion completely blocking the main lymph vessels at the groin or central to this point will cause lymph stasis of the entire limb, and it is highly probable that the intensity and the duration of lymph stasis in any instance of thrombophlebitis is dependent upon the violence of the inflammatory reaction associated

with the thrombosis, with the length of the thrombosed area and with the haphazard local anatomic variation which the lymphatics seem to possess.

Experiments of Reichert, based on earlier suggestive work of the late Professor Halsted, in which the latter attempted to produce elephantiasis chirurgica in dogs by replantation of the hind leg, throw light upon the relation of venous and lymphatic obstruction to swelling of a limb. Reichert made a complete circular incision of the thigh down to the bone, sparing only the femoral artery and vein but dividing their adventitia; then reunited the cut surfaces with great care. In all experiments the limb swelled but showed no sign of gangrene. Swelling began on the second day, reached its height on the fourth or fifth day and had completely subsided by the seventh or eighth day. Injection experiments showed a regeneration of lymphatics beginning on the fourth day. He found that if, on about the eighth day, when the swelling had just subsided, the femoral vein were ligated, no recurrence of œdema appeared nor any untoward symptoms. If ligated while the swelling was at its height, subsidence of œdema was only slightly delayed. If, on the other hand, the lymphatics were blocked with India ink at the time the swelling had just subsided, œdema reappeared. Thus the importance of divided lymphatics as a cause of this swelling was demonstrated. Incidentally Reichert found, as others had before him, that infection and scar-tissue formation decidedly retarded the reestablishment of lymph channels. Apparently, however, no instances of elephantiasis developed among his experimental animals.

Very recently, I have attempted to reproduce in dogs phlegmasia alba dolens. In one animal, under full anæsthesia, the femoral sheath was incised longitudinally just at the inguinal ligament. The vein was carefully isolated and ligated. About two inches below this point the femoral vein was again exposed and elevated upon a fine silk ligature. Two cubic centimetres of muscle juice taken up in saline solution was then injected into the segment of vein so isolated and the intima of the vein scratched with the needle. The lower ligature was then tied, and to be certain that no circulation could pass through the segment, several entering veins were divided as well.

Within forty-eight hours a typical "milk leg" developed, though the animal did not seem distressed and never exhibited any evidence of pain. At the end of four days the œdema was at its height and involved the paw. Thereafter it gradually subsided, though at the end of seven days it was still present, particularly in the thigh. At the end of ten days swelling had disappeared and the animal was killed by chloroform. The vein was found thick-walled and very adherent to the tissues about it. Only a fragment of clot, showing evidence of slight cicatrization, remained. In another animal the common iliac vein was divided in a similar way through an abdominal incision and an even longer segment was isolated by a second division below the inguinal ligament. No entering branches were ligated. Only a slight œdema of the thigh, which reached its height on the second or third day after the operation, developed. The explanation of the failure to obtain a typical œdema in

this instance was found when the animal was killed by chloroform on the eighth day. There was, as compared with the first animal, little or no reaction about the vein. Moreover, no clot could have formed within the supposedly isolated segment, since blood evidently entered it by way of the deep epigastric vein and escaped by way of the internal iliac vein. However, this experiment serves as a good control for the first, that is, it demonstrates the failure of mere *division* of the common iliac and femoral veins to cause any material disturbance of the venous or lymphatic circulation.

In a third dog an attempt was made to interrupt the lymphatics without injury to the vein. Here the sheath surrounding the femoral artery and vein, together with the loose tissue about it, was excised for a distance of about one inch, though the adventitia of the vessels was not completely removed. Then a fragment of gauze was twined loosely about the vessels. Œdema of the thigh down to, but not below, the knee followed. It reached its height on the second and third day; then disappeared. Evidently the interruption of the perivascular lymphatics was not extensive enough to cause any important lymph stasis.

Admittedly, these experiments, though suggestive, are incomplete and require repetition and expansion; but even from the evidence presented here, it appears that phlegmasia alba dolens represents a lymphatic obstruction of uncertain intensity due to inclusion of the trunk lymphatics of the leg in the thrombophlebitic process and that simple division of a vein has no power to cause this obstruction. It remains to explain the reestablishment of the venous circulation and the secondary complications.

It is almost certain that the venous return is cared for, so far as the iliac veins are concerned, by absorption or canalization of the thrombus. In the interval, collateral vessels carry on the venous circulation. For such veins as the iliacs, which have no valves, this means restoration to a nearly normal state. On the other hand, the femoral vein, which depends upon valves for its efficiency, must in all probability be disabled by thrombosis and canalization. If this is the case, why does there not follow a high degree of venous stasis? The explanation probably lies in the remarkably abundant and ingeniously arranged anastomotic channels known to be present among the deep veins of the thigh and leg. Otherwise cyanotic legs would be the rule after a deep phlebitis, which they are not.

The areas of superficial œdema and induration which have already been described as occasional late complications of iliac and femoral thrombosis are explainable upon much the same grounds as true filarial elephantiasis.†

† I was not familiar, when this paper was written, with Matas's clear and convincing description of elephantiasis, especially in its relation to phlebitis, lymphangitis and lymphadenitis, published in 1913. Matas makes no effort to explain the relation of phlebitis to lymph stasis, but discusses the effect of repeated cutaneous infections upon lymphatic obstruction and the permanent states of elephantiasis which he treated with success by the method of Kondoleon. The conditions described by Matas are, of course, more advanced and extensive than those described and figured in this paper but the principle is undoubtedly the same.

They never seem to follow mild instances of phlegmasia alba dolens, but rather those processes which are so obstinate and prolonged as to lead to scar-tissue formation outside of the deep fascia. Although both deep and superficial lymphatics are in the beginning obstructed, there is no evidence that permanent disability is suffered except by the superficial vessels. Bardeleben illustrates the course of the deeper layer of superficial lymphatics in the calf (Figs. 3 and 4), and his description agrees, in the main with that of Reichert. I should judge that it was the destruction of these lymph vessels in particular which causes the characteristic scar formation immediately superficial to the muscular aponeurosis in the calf. Scar formation and lymph stasis tend to form a vicious circle, resistance to infection is low, trauma is common and thus ulceration is in the end almost inevitable.

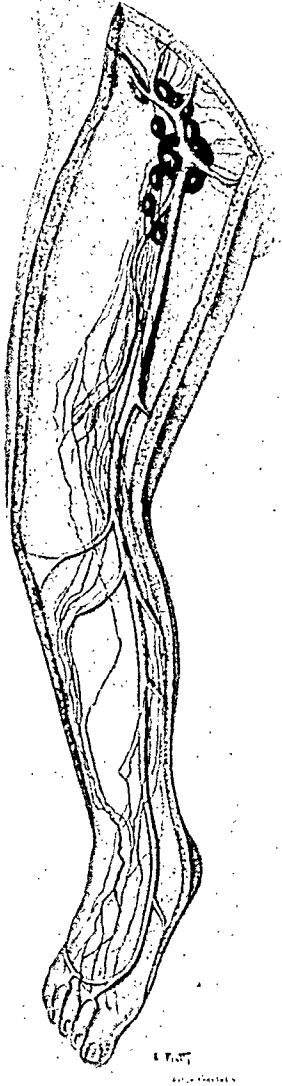


FIG. 3.—The course of the deep layer of superficial lymphatics. These vessels, which at first follow closely the larger trunks of the great and lesser saphenous veins, join the deep lymphatics and follow the femoral vein upward. (After Bardeleben.)

*Superficial Thrombophlebitis.*—Superficial thrombophlebitis, that is, of the great or lesser saphenous systems, causes a more direct and general disability of the surface lymphatics than thrombosis of the deeper veins. Whereas an iliac thrombosis, rapidly resorbed, may cause a widespread but brief swelling of the limb and only indirectly disable the superficial lymph vessels, a saphenous thrombophlebitis is likely to obstruct many superficial lymph channels directly and simultaneously. These channels follow the course of the superficial veins. (See Fig. 3.) That they are gradually disabled and take new courses as varix gradually develops has been offered already as a reason why thrombosis in varicose veins causes so little swelling and induration of the subcutaneous tissues as compared with a no more extensive thrombosis in veins not already varicose.

A very striking demonstration of the effect of a thrombosis in a superficial vein previously normal is offered by the following case:

S. L. Y., entered the Peter Bent Brigham Hospital suffering from pain, redness and swelling along the course of the great saphenous vein and some of its branches in the calf. In the course of several weeks the disease subsided and he left the hospital with some œdema of the calf. A few weeks later he suffered a repetition of the attack, but did not return to the hospital until six months later when the whole front and inner side of the calf were found to be reddened and indurated, with a zone of œdema surrounding the area of most intense inflammation. A week in bed left the local process



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less inflamed but well defined and the hardened veins could be felt in the thigh and leading into the diseased area. Ulceration had not occurred. The saphenous vein was removed from the groin down to, and as far as possible through, the indurated region, and by long, straight incisions two broad strips of thickened deep fascia were excised through the midst of the area and for some distance above and below. Healing was satisfactory, and now, six months later, the leg is vastly improved. Whereas formerly the patient had to spend most of his day with his leg elevated, he is now able to work. However, superficial lymph stasis is not altogether abolished. The operation should, I believe, have been more radical, *i.e.*, more of the deep fascia should have been removed.

This case is fairly illustrative of the late result of a superficial thrombophlebitis. Not all patients develop secondary troubles so rapidly, nor is it possible to say what proportion suffer late complications. If, however, the original attack is severe, and particularly if it is repeated, lymphatic obstruction and its consequences are almost inevitable. It appears also that an attack of superficial thrombosis permanently disables the great saphenous vein and many of its branches, so that the veins, though small and fibrous, are valveless. Moreover, the perforating veins, which should aid the superficial system by carrying blood from it into the deep vessels, are usually rendered incompetent. Thus the surface veins tend to be even more congested with blood than is the case in the ordinary type of varix, and congestion may be so marked as to give the impression that the deep veins are varicose. Such is not the case. I doubt if they ever become varicose, but after a widespread persistent superficial thrombosis, where there is added to the cedema and induration of lymph stasis the congestion due to superficial varicosity and disabled perforating veins, the state of the lower leg is bad and gives the impression that the venous circulation is severely damaged.

*Treatment.*—The treatment of thrombophlebitis in hitherto normal veins naturally divides itself into the management of the thrombophlebitis and of the postphlebitic cedemas and indurations. In respect to the immediate treatment, I doubt whether anything operative can or should be done for an iliac phlebitis unless the patient is clearly suffering from repeated pulmonary infarction and septicæmia. Then the attempt should be made, perhaps, to tie off the common iliac vein or even the vena cava central to the process. In the case of a superficial phlebitis the case is different. Ligation of the great

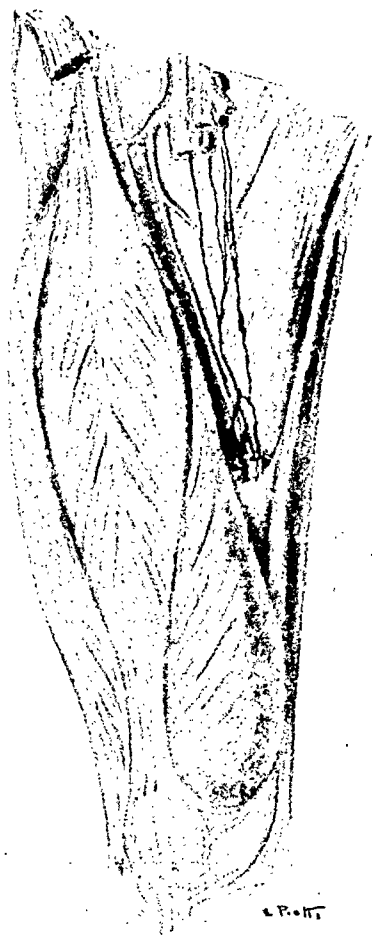


FIG. 4.—The course of the deep lymphatic trunks along the femoral vessels in Hunter's canal. (After Bardeleben.)

saphenous vein above a septic thrombosis is perfectly reasonable, and even excision of much of the thrombosed vessel, provided a streptococcal cellulitis is not threatened, would certainly cut short the disease and might well ward off the late complications.

Elevation and rest of the limb is ordinarily demanded, but I protest against the use of the ice-bag. It gives comfort, to be sure; but if it has



FIG. 5.—M. T. C. No. S. 27214. Late result of excision of ulcer and deep fascia in area of postphlebitic induration. Skin graft. Double "milk leg" six years earlier, which laid patient up for six weeks. Indurated areas developed on both legs, the right more marked. A previous excision without removal of deep fascia had already failed. Patient has slight bilateral varix. Removal of deep fascial strips in both legs is advisable.

any action beneath the surface, it tends to retard the perfectly natural and desirable vascular reaction of the tissue to infection, if that is present, and it devitalizes the tissues. In many instances of deep thrombophlebitis and in the superficial disease, heat is clearly more favorable to the local reaction than cold. Moreover, heat is quite as grateful to the patient.

If, as I have suggested, the late complications of thrombophlebitis are due principally to lymph stasis, attention should be directed as early as possible to restoring the return of both lymph and blood from the leg. One should try to visualize the thrombotic process in each case. If it is attended by little fever and local tenderness, it will soon become absorbed, or organized and canalized, so that the fear of detachment of a clot

by exercise after improvement has begun need hardly be entertained. Therefore, in the milder cases, exercise of the leg in an elevated position within a week or ten days after the process has passed its height should be begun. In severe infections, elevation should be maintained until fever has disappeared and local tenderness is absent. Then gentle motion in bed should be started. Later, light massage will be helpful. We are all too fearful of active exercises in an elevated position, forgetting to what the patient is subjected in the course of routine nursing, the use of the bedpan for example.

As the patient begins to get up, the leg should never be left dependent. Active motion is always more favorable to a return of fluid from the legs than relaxation. Periods of activity should be cut short enough to prevent

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tense swelling, and the rapidity with which swelling disappears on elevation gives some idea of the degree of permanent damage present. Bandaging is of little use unless it is beautifully done, but a light and not too tight elastic stocking may be helpful.

The late complications are rather fascinating subjects for surgery and a hint of the obvious indications for treatment has already been given. The tissues should be given new connections with the lymphatics beneath the muscular aponeurosis. To this end, strips of deep fascia should be excised beneath areas of superficial œdema and for some distance above and below them. When the superficial tissues are severely indurated or ulcerated, such a procedure is not enough. *The area most badly damaged should be excised, taking with it the underlying muscular aponeurosis.* Then a skin graft can be placed upon the delicate reticular tissues covering the muscles. (Fig. 5.) Experience alone can indicate what tissues should be excised and what may be treated by excision of fascial strips alone. In any one instance the procedure is so far a matter of judgment that the patient's consent for an operation in several sittings, perhaps, must be had. The tissues must be treated with exaggerated respect.

The results so far have been encouraging. Some patients have been very much improved, others only a little. None have been made worse. Further experience will show, I am sure, that the principle is sound, but technical improvements and, especially, earlier treatment of these peculiar lesions will lead to greater success. Moreover, treatment of the late complications of thrombophlebitis may doubtless to a considerable extent be anticipated when the relation of the lymphatics to thrombophlebitis is better understood.

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# EMBOLECTOMY \*

## REPORT OF THREE CASES

By JOHN DEJ. PEMBERTON, M.D.

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FROM THE MAYO CLINIC

IN AMERICA to-day there is no established operative procedure of equal simplicity fraught with so little risk and with such dramatic potentialities that has been so woefully neglected as embolectomy for circulatory disturbances of the extremities. The reason this operation has not been employed more often can be readily explained by the fact that the rank and file of physicians either do not recognize the early symptoms of embolism or else are not acquainted with this method of reestablishing the circulation. Since September, 1927, I have performed arteriotomy with removal of obstructive embolus four times in three patients. The vessels involved were the common femoral, aorta at its bifurcation, common iliac, and superficial femoral. These cases are reported with the hope of stimulating further interest in this useful branch of surgery.

## REPORT OF CASES

CASE I.—A man, aged fifty-six, came to the Mayo Clinic, August 31, 1927, for a complaint referable to the stomach and heart, which followed an injury that he received in February, 1925, when he fell from a roof sixteen feet high, striking the side of his head and shoulder. Following this accident he was in bed thirty-seven days; dyspnoea was extreme on slight exertion, and there were certain qualitative dyspeptic symptoms. From the time of the injury he had been unable to carry on his work. According to the referring physician, röntgenologic examination showed a diaphragmatic hernia.

Before the patient was examined at the clinic he went to a hotel where he retired about 8 P.M. and went to sleep immediately. About 10 P.M. he was awakened by a severe pain in a cuff-like area about 10 cm. wide, just above the left ankle; it felt as though the bone were dry and would break. The foot was numb. Since April, 1927, he had been having one or two mornings a week, a sensation similar to this one, which would disappear after he had put on his shoe. On this occasion he put on his shoe, but the foot remained asleep and the pain continued. The longer he walked about, the more severe it became. There was some swelling, beginning in the ankle and gradually progressing to the knee. The entire left leg was tight and painful, and was covered by black and brown blotches. About midnight he was unable to stand on the foot. He did not call a physician, however, until early in the morning, when he was immediately taken to the hospital.

I saw the patient about 11 A.M., and found him in what seemed to be a critical condition. He was prostrated, extremely dyspnoeic, and was suffering excruciating pain in the left leg; there was marked auricular fibrillation (rate about 160). There was bluish discoloration in blotches over the leg, beginning at the foot and ending in an irregular line just below the groin. (Fig. 1.) The movements of the foot and leg were limited. The surface temperature of the leg was decidedly lower than that of its

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\* Read before the Southern Surgical Association, December 13, 1927.

## EMBOLECTOMY

fellow, and the only pulsation that could be detected in the leg was over the femoral artery, just below Poupart's ligament. Embolus of the femoral artery was diagnosed, and about fourteen and a half hours after the onset operation was performed under local anaesthesia.

At the point of origin of the profunda, the femoral artery bulged for about 2 or 3 cm. and below this point the superficial femoral artery was narrowed. At the point of bulging the consistence of the vessel was definitely increased; it was incompressible and on palpation appeared to contain solid or semisolid material. The pulsation of the artery ceased at this point. Through a longitudinal incision 2 cm. long, the anterior wall of the artery was opened and two fairly well-organized blood clots extruded immediately. The larger prong-shaped probably 3 or 4 cm. long, the smaller irregularly spherical. (Fig. 2.) After expulsion of the clots there was free bleeding from the mouths of the common femoral, the profunda femoris, and the superficial femoral, the patency of these vessels being thus evident. The opening in the vessel was closed immediately with a running suture of 000 silk which had been previously immersed in liquid vaseline and threaded on a No. 12 sewing needle that had been ground down to a length of a little more than 1 cm. (Fig. 3.) Pressure was then released from the vessel proximally and distally; no bleeding followed. Wound closed, but an untied fish-line silk ligature was left around the common femoral artery above point of opening, to control any secondary bleeding that might occur.

Immediately after the operation there was improvement in the condition of the leg. The color returned to normal except in the foot and for a distance of 12 or 15 cm. above the ankle. This area was decidedly more cyanosed than before the operation and the patient complained of considerable pain. Heat was applied to the leg and treatment by diathermy instituted. The cyanosis gradually disappeared, so that after the lapse of thirty-six hours the leg had resumed normal color. Convalescence was practically uneventful, the patient was out of bed on the twenty-third day and was dismissed on the thirty-eighth day after the operation.

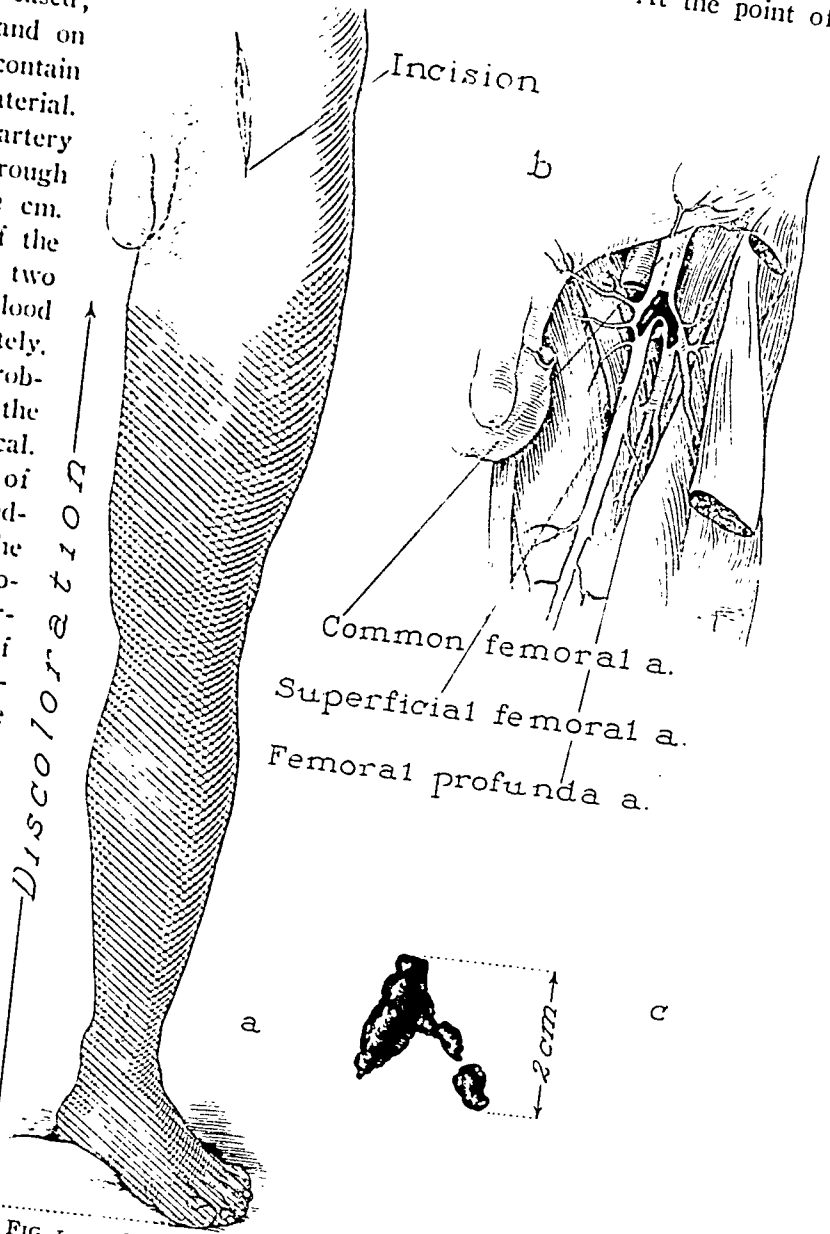


FIG. 1.—a, The extent of the area of ischemia and discoloration; b, Clot *in situ* blocking superficial femoral and femoral profunda arteries; c, Embolus removed. (Case I.)

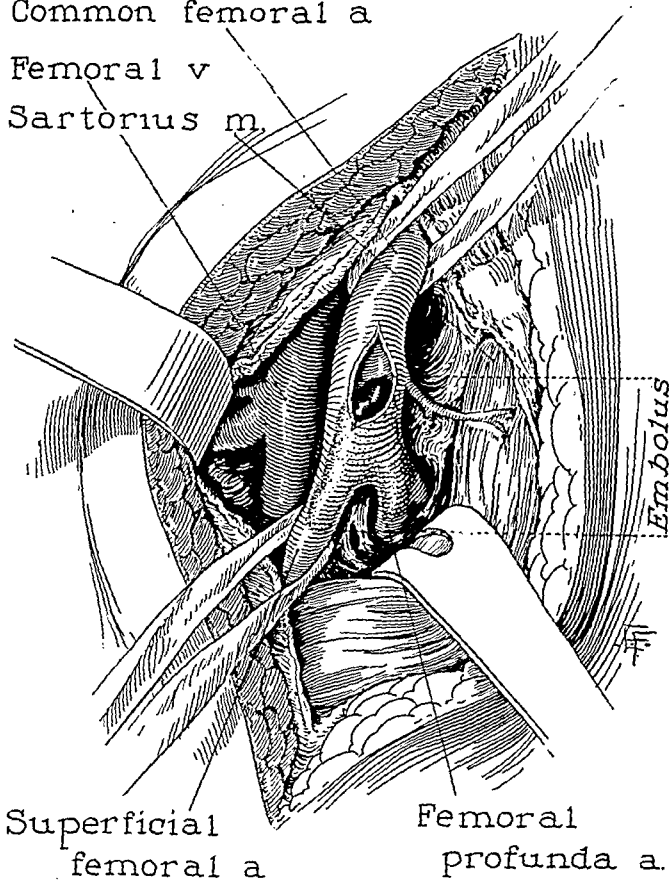
After complete cardiologic examination the diagnosis was made of angina pectoris, severe coronary sclerosis and marked myocardial degeneration. The electrocardiogram showed auricular fibrillation (rate 114) with ventricular premature contraction, left ventricular preponderance, and inversion of the T-wave in all three leads.

CASE II.—A housewife, aged thirty-five, came to the clinic, September 22, 1927, because of convulsions. At the age of fifteen chorea developed and since then she had had shortness of breath and slight œdema of the feet from time to time. Her health had been good until May, 1926, when abortion occurred after two months of pregnancy.

Common femoral a

Femoral v

Sartorius m.



Superficial  
femoral a

Femoral  
profunda a.

FIG. 2.—Exposure of common femoral artery showing embolus *in situ*. (Case I.)

Seven days later, while she was sitting in a chair, she suddenly felt faint and the entire left side became paralyzed; her mouth was drawn and she was aphasic. After two days she was able to speak and move her limbs; in three weeks she was up and about. The left side, however, remained weak for several months. Beginning in August, 1927, "spells" had occurred that were characterized by a peculiar feeling of heaviness in the head, a weak voice, and partial loss of hearing. During attacks she usually wanted to lie down. There had been no convulsions or loss of consciousness. The attacks varied in duration from three minutes to two hours and were followed by dull frontal headache and vomiting. The interval between the first and second attack was about three months, but the attacks became progressively more frequent and of longer duration. With the

last seizure, September 19, 1927, she frothed at the mouth, bit her tongue and rolled her eyes. After this attack she was apparently dazed and aphasic for awhile.

General examination in the hospital showed a fairly well-developed and well-nourished woman, who appeared to be in a semi-dazed condition. The patient was apparently able to comprehend questions, but answered only after they had been put to her several times. Her answers were intelligent but her voice was feeble and indistinct. The temperature and pulse were normal. The systolic blood-pressure was 110, and the diastolic 74. There was a systolic murmur at the apex. There was no œdema. The blood count, blood Wassermann test and analysis of the urine were essentially negative. Ophthalmologic examination showed ocular movements, pupil reflexes and ocular fields essentially normal, and fundi negative. September 26, 6 c.c. of clear normal cerebral fluid was removed; the pressure was 1 cm. and there was prompt response to jugular pressure. A diagnosis was made of chronic endocarditis with mitral stenosis and ancient cerebral embolism.

October 1, the patient was out of bed and had been walking a little. About 8 A.M.,

while sitting in a chair, she was suddenly seized with severe pain in the legs. About 11 A.M. the pain finally settled in the right leg. Examination at this time showed extreme marble-like blanching from the foot to the knee, except for two areas of bluish discoloration on the dorsum of the foot. The temperature of the right leg was definitely lower than that of the left. Pulsation could not be palpated in any of the vessels on the right side and sensation in the foot and leg to the knee was definitely diminished. Blood did not follow deep needle puncture of the foot. There were no movements in the foot but the patient was able to bend the knee. There was no area of tenderness or diminution of power in the left leg. There was no distinct pulsation of the left femoral artery, but on auscultation there seemed to be a faint sound over it. Slight bleeding followed needle puncture of the foot. A diagnosis was made of an embolus in the common iliac and operation was advised. On account of the patient's peculiar mental status, it was impossible to get her consent for several hours, and operation was delayed until 3 P.M., seven hours after the onset of the first symptoms.

Under local anesthesia an incision about 8 cm. long was made over the right common femoral artery and the artery was exposed just below Poupart's ligament. There was no pulsation, and the artery was narrowed to about half normal size; clots were not palpated. (Fig. 4.) A vertical incision, about 2 cm. long, was made in the anterior wall. Immediately there ex-

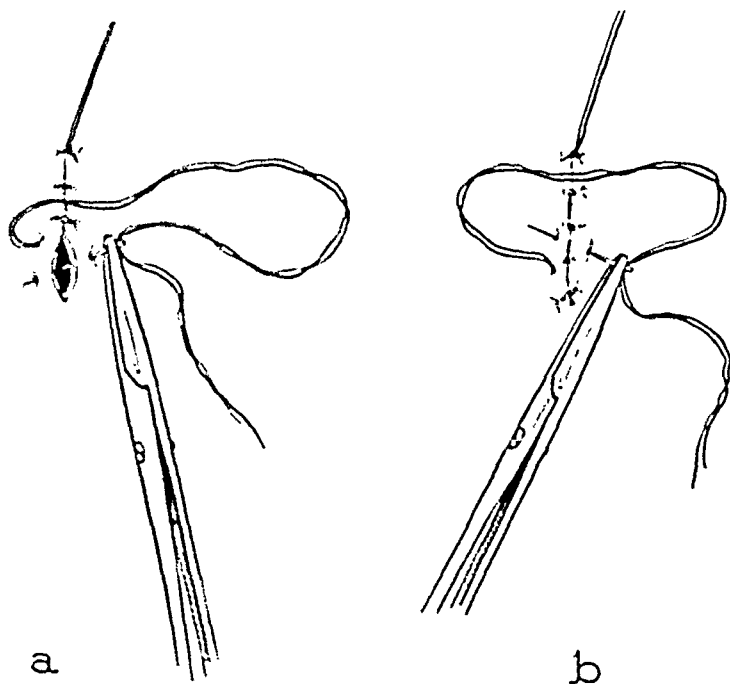


FIG. 3.—Method of closing arteriotomy wound. (Case I.)

uded parts of a soft thrombus. Small curved duct forceps were inserted distally and more of the soft thrombus was removed; only slight bleeding followed. There was no bleeding from the proximal end. Forceps and a uterine probe were passed up into the lumen of the external iliac, the forceps for a distance of about 13 cm. and the probe for 20 cm. The probe at this point seemed to meet with an impassable obstruction. The incision in the skin was carried up for 10 or 15 cm. on the abdominal wall. The aponeurosis of the external oblique was divided, the internal oblique fibres were separated, and the external iliac artery exposed and then traced with the fingers by pushing the peritoneum ahead. At a point near the promontory of the sacrum, pulsations of the abdominal aorta could be distinguished. Below this point the common iliac was milked and something was felt crunching between the fingers. After further milking, it was evident that the embolus was dislodged into the common iliac, for the pulsations were now more distal than was noted at first. The forceps were pushed up into the artery as far as possible, the jaws closed, and then withdrawn; with it there came a long branched thrombus about 7 or 8 cm. long, evidently from the iliac and its two branches. (Fig. 5.) Immediately a large irregularly cone-shaped clot (embolus), about 3 by 5 cm., shot out of the artery followed by an unimpeded stream of arterial blood. There was no bleeding from the distal end of the femoral artery, which was gently probed downward without meeting obstruction for from 10 to 12 cm. The opening in the artery was closed by a running suture of 000 silk threaded on a fine straight artery needle. Pressure was released from the artery proximally, and slight

bleeding from the suture line followed. A second row of silk was then placed in the artery; there was no bleeding. The wound was closed, an untied fish-line suture being left around the femoral artery, proximal to the suture line. The ends of the thread were brought out of the wound so that they could be tied if secondary hemorrhage occurred. After the operation a faint pulsation was felt in the popliteal. The color of the skin over the foot was now changed from blanched to mottled blue; the patient was able to move the foot and toes.

Immediately on the patient's return to bed, external heat in the form of hot water bottles and medical diathermy was applied to the right leg, and normal color and motility

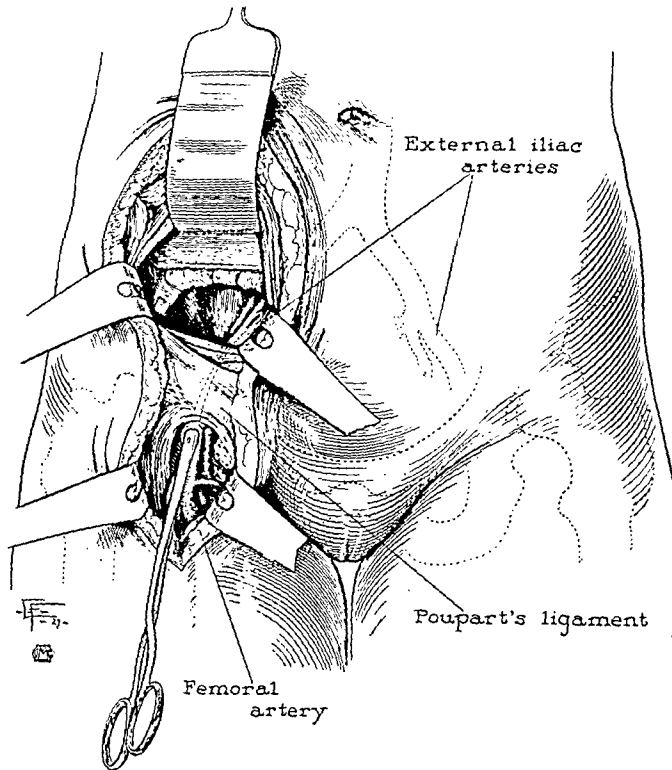


FIG. 4.—Method of approach for the removal of an aortic embolus. (Case II.)

rigid "drop" position. Operation on the left leg was urged, but the patient refused. Later, however, she consented, and at 9.30 A.M., about twenty-five and a half hours after the onset of symptoms of partial occlusion, and about six and a half hours after the onset of symptoms of complete occlusion, the operation was performed under local anæsthesia.

The upper part of the left common femoral artery was exposed in a manner similar to that on the right side. The artery, which was collapsed, was opened, and only a small amount of soft thrombus came out. Probing with gall-duct forceps for 12 to 16 cm. was not followed by free bleeding, so the incision was carried up over the abdomen and the external iliac exposed retroperitoneally. In doing this a small opening was made in the peritoneum; it was closed immediately. With the probe as a guide, the artery was traced by the finger as high as its bifurcation, where pulsation could be felt. (Fig. 6.) By milking the artery, the pulsation came more and more distally until the embolus (a flat clot about 0.5 by 2.0 by 0.5 cm. rolled up into a cone-shaped plug) was withdrawn. Free bleeding followed immediately. The opening in the femoral artery was then closed, with some tearing of the wall; in order to get tight approximation the lumen was necessarily constricted. Before closure it was noticed that the intima of the artery on the posterior wall opposite the incision was injured. After closure, pulsation came

were soon restored. However, she then began to complain of severe pain in the left leg, worse around the knee. The possibility of a second embolus was considered, but since there was no appreciable change in the color of the leg or in the sensation or motility, a definite diagnosis could not be made, even though one could not be sure of obtaining the femoral pulse. The leg was examined at intervals of half an hour to an hour during the course of the evening and night, and there was no change until about 3.30 A.M. when definite blanching of the foot and leg up to the knee, with loss of motion and sensation occurred. The leg was bluish and mottled; the extremity had a post-mortem lividity, and was cold up to the knee. The foot was in a



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through, but before the wound was closed this had ceased. Accordingly, the artery was opened at a point about 4 cm. below and the thrombus removed, but about as soon as the artery was closed there was further clotting in the vessel at the point of the first opening. The stitches in the lower or second wound were removed, a second clot extracted and the incision again sutured. Pulsation continued for about five minutes, then ceased. As further probing did not seem warranted, the wound was closed.

Following the operation the patient was in a state of considerable shock. The temperature and pulse rose rapidly, the temperature mounting to 100° F. She grew progressively worse and died about ten hours after the operation. The condition of the left leg, circulation in the right leg and foot remained good. The condition of the left leg, however, was not improved by the operation.

Necropsy showed chronic rheumatic mitral endocarditis with stenosis, multiple embolic infarctions of the brain and kidneys, cholelithiasis and chronic pericarditis. The aorta and both the iliac and femoral arteries were dissected out and the lumen of the right iliac and both femoral arteries was entirely free, without evidence of thrombus at the suture lines. (Fig. 7.) On the left side, however, a fairly well-organized thrombus extended from the beginning of the iliac down through the femoral distal to the suture line.

CASE III.—A woman, aged sixty, entered the Mayo Clinic, October 31, 1927, because of goitre and heart trouble. She stated that the goitre had been present for twenty years and that it had diminished slightly in size during the last three or four years. She had been slightly breathless for the last four years and the blood-pressure had been high for about the same time. For approximately two years the heart beat had been rapid and had palpitated much worse during the last four months. There was also a certain degree of heat intolerance and increased perspiration. The appetite was always good and there was no gastro-intestinal disturbance. She had gradually lost twenty-six pounds during the last three years and had become rather shaky. She had been more dyspnoeic in the last year and had to sleep with several pillows under her head. The ankles were sometimes slightly cedematous. Since July she had been in bed a good deal. She had a fright June 28, 1927, and had partial aphasia for about two weeks. Her husband thought she had had a stroke. There had been no paralysis, however. Iodine (Lugol's solution 30 to 45 minims daily) had been given most of the time since July; also varying amounts of digitalis. A distressing cough with slight mucoid expectoration had been present for the last six months.

Examination in the hospital showed an exhausted patient with dyspnoea and considerable orthopnoea; the lips were slightly cyanotic. There was considerable vascular sclerosis. The skin was warm and moist. There was marked weakness of the quadriceps, a large adenoma of left lobe and the isthmus of the thyroid and also enlargement

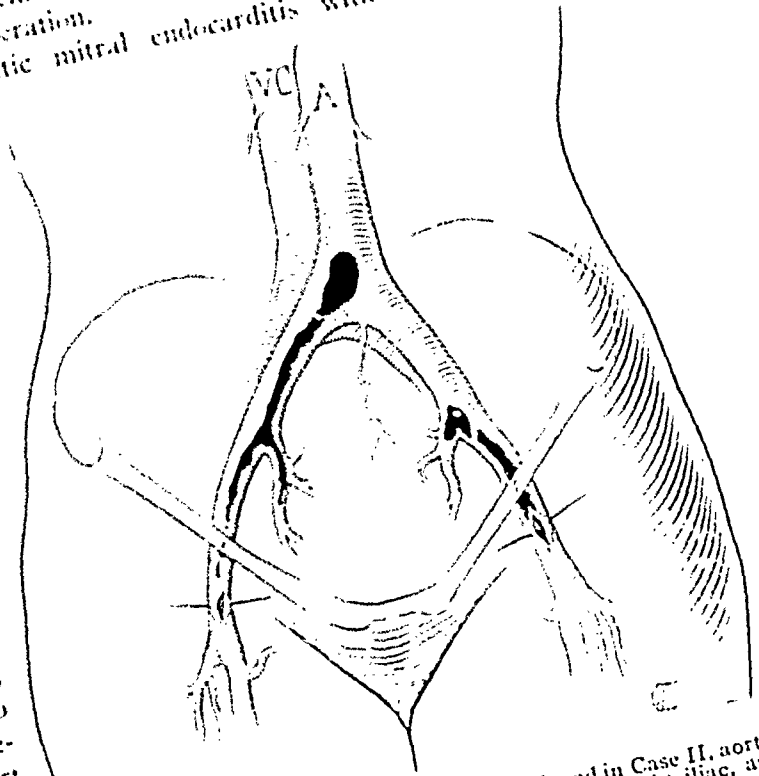


FIG. 5.—Diagrammatic sketch of condition found in Case II, aortic embolus with secondary thrombus formation in the right iliac, and left common iliac embolus.

of right lobe, but no bruits. The heart was moderately enlarged to the left, there was rhythm of auricular fibrillation, and the apical rate was 132 without pulse deficit when the patient was lying down. The systolic blood-pressure varied from 180 to 190, and the diastolic from 92 to 96. The liver was not definitely palpable. There was slight œdema over the tibias, tremor of the left hand, more noticeable on movement, and the small joints of the fingers were enlarged. The basal metabolic rate was 49. The blood count, the blood Wassermann test and the urinalysis were negative. Röntgenograms of the chest showed that the heart was moderately enlarged and that there was some passive congestion. A clinical diagnosis was made of adenomatous goitre with hyperthyroidism,

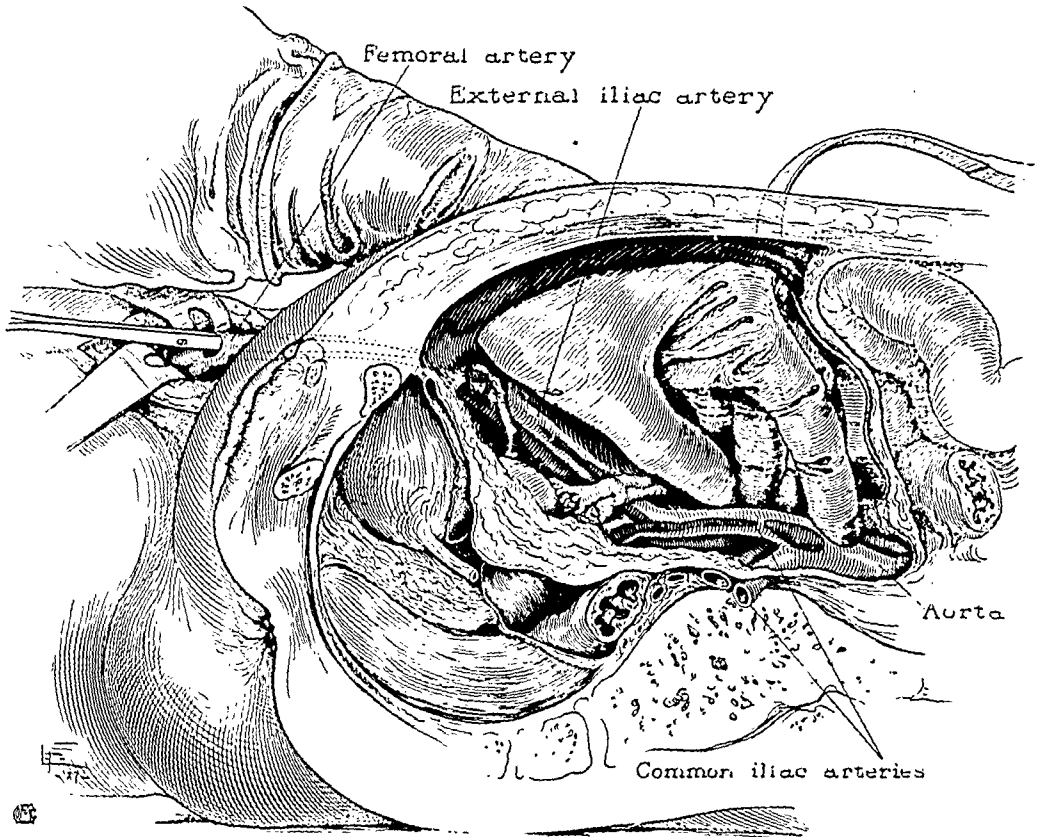


FIG. 6.—Sagittal section; method of "milking" down an aortic embolus through a retroperitoneal approach. (Case II.)

essential vascular hypertension with general cerebrospinal arteriosclerosis, myocardial degeneration with partial decompensation and residuum of cerebral vascular accident.

The patient was kept at rest and given Lugol's solution, 10 minims three times a day. There was some improvement until the twenty-second day after admission, when the heart began to fibrillate more rapidly, and the patient complained of sudden pain in the left foot and anterior part of the left leg. The pain was continuous and it was described as a burning, tingling sensation as though the foot and leg were asleep and circulation was returning. Examination at this time showed the left leg colder than the right. There was no blanching but there was a slight suggestion of cyanosis. The superficial veins in the left leg stood out more prominently than those in the right. There was no pulsation in the left dorsalis pedis or in the posterior tibial, but pulsation in the left popliteal appeared to be definitely diminished. The foot and leg remained this way for four days, when the patient complained of sudden severe pain, most marked in the foot and anterior tibial region. The pain was continuous and of a burning type. The patient was flushed and sweaty; she appeared to be in great agony. Auricular fibrillation was rapid. The left leg up to the level of the knee was markedly cyanotic, there was



Surgery of blood-vessels is of comparatively recent development and the number of operations recorded for the removal of obstructive arterial emboli are not numerous. The first attempt was made in 1895 by Ssabanejew. He opened the femoral artery because of threatening gangrene of the leg, but failed to find the embolus. Two years later Moynihan removed an embolus from the popliteal artery. The patient died four days later. In 1907, Stewart performed arteriotomy and extracted an embolus of thirty-six hours' duration from the femoral artery. Circulation to the limb was reestablished temporarily, but forty-two days later it was necessary to amputate the leg below the tubercle. In the same year Doberauer removed an embolus from

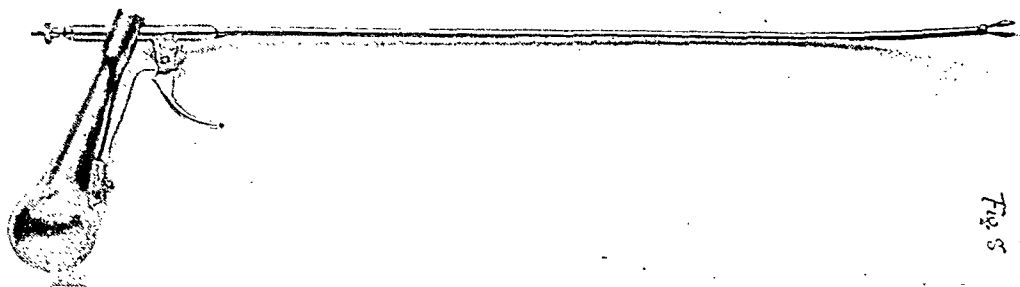


FIG. 8.—Embolus forceps, devised for the removal of the emboli inaccessible to direct approach.

the axillary artery, fifty-two hours after its lodgement. Thrombosis followed and two days later he made an arteriovenous fistula between the axillary vessels with the idea of restoring circulation to the hand. In this year Trendelenburg made a bold attempt to remove a pulmonary embolus. In 1908, Proust and in 1909, Schiassi, Murphy, and Carrell and Leriche, performed arteriotomy for the removal of emboli from the vessels of the extremities, but none was successful in reestablishing the circulation.

The first embolectomy carried out with good results was that of Lahey, performed in 1911. In the following year Key performed the second successful operation, and to Key belongs the credit for developing this field of surgery. It is estimated that up to the present time less than 150 cases of embolectomy have been reported in the literature. Most of the operations have been performed by Scandinavian surgeons; there were ninety-five in Sweden from 1912 to 1925 inclusive. In this series were seventeen operations on fifteen patients by Key. Less than twenty operations have been reported from the United States, Canada and England. All of these were performed for circulatory disturbances in the extremities and the vessels involved included the aorta at its bifurcation, the iliac, femoral, popliteal, subclavian, axillary, brachial, ulnar and radial arteries.

*Origin of Emboli.*—The possible sources of arterial emboli in the general circulation are: (1) A central spot in the arterial tree; (2) the left side of

the heart; (3) the pulmonary veins; (4) the right side of the heart, and (5) the systemic veins. In order that an embolus may lodge in the general arterial circulation from the right side of the heart or systemic veins, there must be a patent foramen ovale; the embolus is then spoken of as a "paradoxical" or "cross" embolus. Nyström recently reported a verified case of paradoxical emboli arising from thrombosis of the iliac veins and lodging in both common iliac arteries. After the emboli had been successfully removed the patient died from cerebral and pulmonary embolism. Necropsy revealed a patent foramen ovale, thrombosis of iliac veins and cerebral and pulmonary emboli. Of the cases reported in the literature in which operation was performed the heart was diseased in more than 80 per cent. Willius has found that cardiac emboli occur in about 25 per cent. of all patients dying from disease of the heart. While emboli are prone to occur in endocardial valvular disease, particularly mitral stenosis, he shows that no form of heart disease is free from the perils of embolism. Willius explains the frequency of mural thrombosis in the auricles in auricular fibrillation by the fact that these chambers are no longer dynamic, and thus favor stasis and the development of coagulation of the blood elements. Bull examined more than 6000 necropsy records at Rik's Hospital, Oslo, with the view of ascertaining the number of cases of embolism of the extremities with or without gangrene, and of determining the primary thrombus. Embolism of the extremity occurred fifteen times, fourteen times in the lower extremity and once in the upper; in seven of these cases there was no gangrene. The thrombus was in the cardiac chambers in thirteen cases and in the aorta in the other two. Among 6140 necropsies thrombosis was found in the arteries and heart in 243 cases (about 4 per cent.), in the aorta only in nine cases (advanced atheroma), in the pulmonary veins in three cases, and in the heart, involving the valves, or more frequently in one or more of the chambers (right side in sixty-seven cases, left side in sixty-three cases, both sides in fifty-one cases). Commenting on the frequency with which thrombosis is found in both sides of the heart, Bull emphasizes that a patent foramen ovale is not necessary to explain the simultaneous occurrence of emboli in the pulmonary and general circulation.

Embolism of an extremity may follow an operation or an infectious disease when there is no demonstrable lesion of the heart. It is probable that low-grade infection is an important causal factor of all emboli. On the basis of such speculation the marked variation in secondary thrombus propagation following the lodgement of an embolus could readily be explained by the difference in the virulence of the infecting organism.

It is difficult to determine the incidence of embolism of the large arteries of the extremities but undoubtedly it is higher than is generally believed. In approximately 200,000 registrations in the Mayo Clinic, the histories and data regarding twenty-one cases of circulatory disturbances of the extremities were definitely the result of obstructing arterial embolus. In three others the data were suggestive of embolism.

When a thrombus is detached from the wall of the heart, it is caught in the current of the blood stream and carried rapidly out through the arterial channels until it reaches a point of narrowing of the artery, such as a bifurcation or where a large branch is given off. Here the embolus lodges and owing to the fact that its shape is then molded by secondary thrombosis to conform to the contour of the lumen of the vessels, the clot is often found at operation to be saddle-shaped or prong-shaped or to resemble a molar tooth. For this reason the embolus will probably obstruct not only the principal artery, but its main branch, thus diminishing the chances of the establishment of adequate circulation to the extremity. If the blockage is not removed early by embolectomy a secondary thrombus forms as a rule distal to the clot, thus interfering with collateral circulation, as illustrated in Case III. Five days before operation there were definite symptoms of embolism in the femoral artery with pain, blanching of the foot and diminished pulsation in the popliteal artery, indicating either incomplete or complete blockage with efficient collateral circulation. This condition remained about stationary until three hours before operation, when pain became more severe, popliteal pulsation ceased, and evidence of impending gangrene appeared. Operation revealed extensive secondary thrombosis. However, the tendency to secondary thrombus building is not constant in all arterial emboli, for occasionally adequate collateral circulation is established and the vitality of the limb preserved.

*Symptoms.*—The characteristic symptoms of embolism are those of ischæmia of the extremity. The subjective symptoms are sudden severe stabbing pain, a sensation of cold and numbness, and disturbance of sensibility. The objective symptoms are change in color of the skin, which becomes marble-white, blotchy, ashen or cyanotic, decrease in the temperature, disturbed motility, absence of skin and tendon reflexes and absence of pulsation. The sudden blockage of a large artery will throw an additional burden on the heart, which if already injured may result in great prostration, with tachycardia, fibrillation, cyanosis and dyspnoea. Key states that there may be, before the onset of circulatory disturbances, certain prodromal symptoms due to small emboli. Not infrequently in cases of femoral embolism the patient first complains of pain in both legs, then with the appearance of the ischæmia the pain is confined to one leg. It is believed that the embolus is arrested momentarily at the aorta, straddles the bifurcation and thereby produces partial obstruction to both iliac arteries.

*Diagnosis.*—The diagnosis is readily made if the obstruction is complete. However, the condition must not be confused with venous thrombosis in which the extremity is warm, cyanotic and swollen, pulsation is present, sensations are unchanged and the veins are often painful. The circulatory disturbances of the extremity from arterial thrombosis due to endarteritis obliterans or arteriosclerosis are readily differentiated by the presence of prodromal symptoms and the slow extension of the process observed in these

conditions. Functional circulatory disturbances are not likely to be confused with embolism.

*Localization.*—As the embolus is generally found lodged at the bifurcation of branching of the vessel and as the obstruction is always central to the upper limits of the area of ischæmia, the localization of the clot usually offers but little difficulty. Furthermore, in many instances the point where pulsations cease can be determined by palpation; if patients are very thin even the nodular enlargement of the vessel produced by the embolus may be palpated. Difficulties of localization may be encountered in the presence of multiple emboli, secondary thrombus formation, and in cases of embolus at the bifurcation of the aorta which may completely obstruct one common iliac artery and only partially obstruct the other, resulting in indefinite symptoms on that side. The latter condition was noted in one of Key's cases, also in my Case II.

*Treatment.*—The treatment may be divided into surgical and non-surgical. The non-surgical treatment consists of the application of heat to the extremity with the hope of favoring the establishment of collateral circulation, or vigorous massage of the limb over the site of the embolus with the idea of breaking up the clot, thereby permitting its distribution to smaller peripheral vessels. While successful reestablishment of the circulation has followed both of these procedures, the non-surgical method should be considered only when a very small vessel of the extremity is involved with little evidence pointing to impending gangrene or if the patient is critically ill and unable to stand any operative procedure. Before advising the employment of non-surgical treatment it should be borne in mind that the blockage of the principal artery of an extremity by an embolus is laden with greater danger of gangrene than a similar blockage by a ligature. If a vessel is obstructed by an embolus two other factors diminish the chances of the establishment of collateral circulation: the embolism is likely to be lodged at the point of origin of a large vessel and as a rule obstructs it as well as the principal artery of the extremity, and an embolus is more likely to propagate the formation of thrombi than is a simple ligature.

The surgical procedures that may be indicated are arteriotomy with the removal of the obturating clot, and ligation of the vein accompanying the obstructed artery. Embolectomy, performed as soon as possible after the onset of the obstruction is the ideal procedure. Delay in removing an embolus increases the chances of thrombosis in the artery, and decreases the vitality of the tissues of the extremity by continued suspension of the circulation. The presence of either of these complications lessens the chances of success of the operation. As emphasized by Key, the operation should be employed in all cases in which circulatory changes are threatening and also in cases in which there is beginning gangrene: in the first instance to prevent the development of gangrene, and in the second to restrict its spread.

The operative technic is simple. Under local anæsthesia the artery is

exposed and incised at or just above the site of the embolus and the obturating clot or clots are removed with the least possible injury to the intima. If the operation is prolonged, the edges of the wound are kept moistened by compresses soaked in 2 per cent. solution of sodium citrate. The wound in the vessel is closed by interrupted or continuous suture of 000 silk, which has been immersed in liquid vaseline and threaded on a No. 12 sewing needle, ground down to about 1 cm. long. When the iliac artery, the aorta at its bifurcation, or the subclavian artery is involved, direct approach is difficult if the patient is obese, and inadvisable if the patient is in poor condition. In such case it has been suggested that the incision in the artery be made at a point easy of approach, such as the femoral or the axillary artery; then if the vessel is gently probed at a point nearer the heart, the clot may be dislodged and removed through the opening in the femoral or axillary artery. (Figs. 6 and 8.) There are published reports of successful removal of an embolus at the bifurcation of the aorta by means of both the direct transperitoneal approach and the indirect retrograde probing. Certainly if the patient is obese or critically ill, the latter method is to be preferred. If it is impossible to dislodge the clot by probing, this method may be supplemented by exposing the iliac artery and the aorta retroperitoneally and gently milking the vessels until the embolus is dislodged. The aortic embolus in Case II was successfully removed in this manner through an opening in the right femoral artery. The patient died from secondary thrombosis in the left common iliac, the result of failure to expose and open the left femoral artery at the time of the right femoral arteriotomy. Key emphatically urges this procedure because of the frequency with which an aortic embolus plugs the opening of both common iliac arteries. Late in the case when it is impossible to reëstablish the circulation on account of injury to the intima caused by prolonged contact with the thrombus, the collateral circulation may be improved by ligation of the companion vein at the site of the arterial obstruction or preferably at a more central point. Makins proved conclusively that when the principal artery to an extremity is blocked, the ligation of the companion vein materially increases the blood-pressure in the distal parts. Holman showed further that the blood-pressure will be raised still higher if the vein is ligated at a point equidistant to the arterial obstruction.

*Results.*—The results of embolectomy are influenced by certain factors: (1) The time elapsing between the lodgement of the embolus and its surgical removal; (2) the number of emboli; (3) the condition of the patient, and (4) the vessel obstructed. In the literature there is only one record of successful restoration of the circulation in any case of twenty-four hours' duration or longer; Key recently reported a successful result following surgery for an axillary embolus of forty-eight hours' duration. Jefferson reviewed the records of twenty-eight cases of embolectomy performed in the period between 1922 and 1925. The results were satisfactory in fifteen. Most of the operations were performed in the Scandinavian countries where



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the influence of Key's teachings is greatest. Of the seventeen operations of embolectomy performed by Key since 1912, eight were successful. This is an excellent record, for as summarized by Jefferson, "in the nature of things a very high percentage of successes is unlikely ever to be attained, for emboli are apt to be multiple and further infarction elsewhere will sometimes carry off the patient in whom a local success has been won; moreover, the advanced age of the patient and the frequency of heart disease often make the subjects bad surgical risks."

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## ARTERIAL EMBOLLECTOMY\*

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THIS paper is based upon a study of ninety-five cases of embolectomy gathered from the literature of American, Canadian, English, Swiss, French and Scandinavian surgeons and a report of three cases operated upon by the author, making a total of ninety-eight cases.

The removal of an embolus from an artery has been made possible through the development of the modern technic of blood-vessel surgery. The first attempts were unsuccessful probably on account of lack of proper understanding of the principles underlying the surgery of blood-vessels, and also because in most of the cases that came to operation the circulatory disturbance was too far advanced. Restitution of circulation could not be obtained and amputation for gangrene of the limb was the usual result.

It is only within the last decade that arteriotomy for embolectomy has begun to give encouraging results. The first arteriotomy for the removal of an embolus was performed in 1895 by Suabanejew for threatened gangrene of the leg. The femoral artery was opened, the embolus removed, but the operation was not successful.

Several surgeons had tried to remove emboli or arterial thrombi during the decade following its first performance, but were not successful. In 1909, Dr. John B. Murphy removed an embolus lodged in the common iliac artery near the bifurcation of the aorta. The operative diagnosis was thrombosis of the left femoral and an incision into that artery was made, but after opening the vessel, it was found that the obstruction was higher up. By means of a ureteral catheter introduced into the femoral artery as far as the bifurcation of the aorta, he was able to dislodge the obstructing clot. The opening in the artery was then closed with fine silk sutures threaded on a conjunctival needle. The operation was unsuccessful, gangrene developed, and amputation of the leg was necessary.

The first completely successful embolectomy was performed by Labey in 1911. He removed an embolus from the femoral artery six hours after its appearance. Dr. Einer Key of Stockholm, whose publication in 1922 is considered to be the most important contribution to the subject, performed the second successful embolectomy one year later. In his case the embolus was also lodged in the femoral artery. Since that time Key has performed this operation ten times on nine patients. In eight out of his ten cases, the emboli were located in the lower extremity and two in the upper extremity. Gangrene appeared in four of the operated cases and the result was good in the

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remaining six. He collected fifty-one other cases from the literature and he states that in no instance has the operation been fully successful when it was performed more than twenty-four hours after the onset of the obstruction. In reviewing the literature since the publishing of Key's paper in 1922, we found a report by Lian and Maure in 1925 in a case of axillary obstruction of twenty-nine hours' duration.

Early diagnosis and immediate surgery is advocated by all. The best results were obtained in those cases where the operation was performed within the first twelve hours after the onset of the obstruction. The sooner embolectomy is carried out after the onset of the condition the better are the prospects of success. If no attempt is made to dislodge the clot until the lapse of a few hours after its onset, secondary thrombi will form and cause obstruction to a large segment of the arterial canal. Degenerative changes may take place in the intima of the vessel at the site of the thrombus or embolus. These changes interfere with the flow of blood within the lumen of the vessel, even after the clot has been completely removed.

Most of the early cases were reported by Scandinavian surgeons, but since the publication of Key's paper, we notice from a review of the literature that there is a slow but steady increase in the number of cases reported by American and continental surgeons. But the reports from the Scandinavian literature still predominate over that of any single individual country.

The subject is worthy of discussion from many angles. This condition is not of a very frequent occurrence and it is not usually recognized in its early manifestations by the general practitioner or surgeon. The importance of early surgical intervention is not fully appreciated. Early recognition of its symptoms, and a prompt diagnosis are essential, if satisfactory results are to be obtained by operative interference. The technic of the operation is not very complicated or difficult, because the emboli usually lodge in vessels that are most accessible. As we shall see from report of the cases, most of the emboli were in the large vessels of the upper or lower extremities and mostly near the bifurcation points such as the profunda brachialis or profunda femoris. The localization of the embolic site is not difficult to establish, particularly in the vessels of the extremities where the presence or absence of pulsation can be ascertained so easily.

The symptoms that usually characterize an embolus may be divided into the subjective and the objective. The subjective symptoms are, sudden onset of pain, a sensation of coldness and numbness of the extremity. The pain may be very severe with onset of obstruction and gradually diminish in intensity as the blood supply to affected part is progressively lessened. The objective signs are, change in color of the skin, the lowering of the temperature of the affected part, some disturbance of motility, and the most important of all, the absence of pulsation in the artery supplying the affected part.

As a result of the suspension of circulation, there is a marked anemia of the affected extremity. The skin becomes pale and somewhat cyanotic. As the obstruction continues, the discoloration may be seen, in livid, dark blue

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patches. Motility is restricted and may be entirely suspended depending upon the degree of circulatory disturbance.

In one of my own cases, I was able to locate the embolus definitely in the brachial artery at about the upper third of the forearm before the incision was made. Palpation demonstrated a small segment of the vessel which had a solid cord-like resistance with pulsation above that point and absence of pulsation below it. In another case, the embolus was lodged in the axillary artery and its location was not difficult to ascertain. In both of these cases, the arteries were easily palpable.

In following the course of an artery where an embolus is suspected of having lodged, one usually notices an absence of pulsation at a certain point. Where the pulsation ceases one may notice a slight bulging or dilatation of the vessel and a sense of resistance within the lumen. The vessel below the point of obstruction is of a distinctly smaller calibre.

In the author's case where the embolus lodged in the brachial artery it was possible to palpate it within the lumen after the artery was exposed and dislodge it upward and downward for a short distance by gently milking the artery digitally. The diagnosis may be difficult in cases where the embolus saddles a bifurcation and is not obstructing the circulation in the beginning and where the arterial disturbance is slowly progressing due to the formation of a secondary thrombus at the embolic site.

It is important to differentiate between an embolus and a thrombus in an artery which is due to an arteritis. In attempting to make a differential diagnosis between these two conditions, one must take into consideration the predisposing causes. In an embolus, the onset is usually sudden. There is a history of organic heart disease or the existence of an acute infectious illness, or closely following upon a surgical operation. In an arterial thrombus, we will usually elicit a history of long standing premonitory symptoms such as a sensation of coldness and of numbness, cyanosis of the peripheral parts of the extremity.

The operation of arteriotomy should always be performed under local anaesthesia. Most of the patients suffering from this disease are usually of low physical resistance, suffering from either poor heart action or septic diseases. It is important that the risk of the operation should be minimized to the fullest extent. Furthermore, as shown before, most of the operations usually have to be performed on vessels that are easily accessible and can be well managed under local anaesthesia.

The technic of the operation must be carried out very scrupulously. After the site of the obstruction is located, the vessel is isolated and lifted from its bed. Small rubberized clamps may be applied at a point above and below the obstruction. Some recommend the constriction of the vessel with a fine rubber tube, while others advise digital compression. My own procedure was to raise the vessel from its bed and constrict it above and below the embolus by means of an ordinary flat sterilized tape.

The vessel is incised longitudinally a little below or above the point of

obstruction and the clot evacuated. This can be done by pulling gently on the clot with very small forceps covered with sterile vaseline or dipped in 2 per cent. citrate solution, or fine scoops may be used. Milking the vessel upward or downward, depending on the location of the clot in its relation to the incision, may dislodge it. The constriction of the vessel above the incision is released and blood allowed to flow freely. If there is no free flow of blood, then the assumption is that there is probably another clot above the arteriotomy wound which is obstructing the circulation. An attempt should be made to dislodge it either by another incision into the vessel higher up or by aspiration through a catheter. If a thrombus is found below the point where the embolus has lodged, then an incision should be made below the point of the primary incision after having put a clamp below in order to prevent the dislodgement of the clots downward. A catheter should then be introduced into the primary incision and the segment of the vessel between the two incisions irrigated with 2 per cent. citrate solution. The incisions in the artery should not be closed before a free flow of blood has been definitely established above the obstructed point.

Proper suturing is a most important factor. The needles should be of the finest size, threaded with fine silk, thoroughly lubricated with sterile vaseline or albolene. Throughout the operation the use of 2 per cent. sodium citrate solution is suggested for sponging in order to prevent coagulation. Key emphasizes the fact that throughout his entire technic, his instruments and gloves are rinsed in the citrate solution. The curettes and probes used for removing the emboli or thrombi should be smeared with sterile vaseline.

The removal of an embolus lodged at the bifurcation of the abdominal aorta presents a much more complicated problem. The general condition is such that will not permit a transperitoneal exposure of the aorta at that point. The following method of procedure is suggested. Both femoral arteries are exposed and clamped. One artery is opened proximal to the clamp and an attempt is made to dislodge the clot by means of uterine sounds, blunt curette or by irrigation if necessary. The clamp is placed on the opposite femoral in order to arrest any fragments of the dislodged clot that may be carried into it. After the clot has been dislodged and blood flows freely, the artery may be temporarily clamped again and an arteriotomy performed proximal to the clamp on the opposite side to permit the escape of the fragments of the broken up embolus which may have come down into it. A clamp is then placed above the opening in the vessel and the incisions in both vessels closed.

The total number of embolectomies that we have been able to collect since Labey's first case is ninety-eight. This number includes the sixty-one cases reported by Key in 1922, of which ten were his own, the remaining fifty-one having been collected by him from the literature. We have made a careful search of the literature published on this subject since 1922 and we found thirty-four additional cases and three of my own, making a total of thirty-seven embolectomies performed since that time. (Chart 1.)

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CHART 1

Total number of cases.....	98
Reported by Key (1922) .....	61
Collected from literature (1922-1927).....	34
Author's cases .....	3

Analysis based on 37 cases, 1922-1927.

	Male	Female
Age		
Oldest .....	72	78
Youngest .....	25	27
Sex		
Male .....		10
Female .....		26
Etiology		
Cardio-vascular disease .....		22
Parturition .....		3
Post-operative .....		6
Not mentioned .....		6

The discussion of the post-operative results, the technic of the operation, and the time element as is shown in the charts is based upon an analysis of these thirty-seven cases. The operations were performed by twenty-four different surgeons, the latest case included in the series is reported from the Mayo Clinic. Operation was performed by Pemberton on October 5, 1927.

Sixteen surgeons report only one case each. Four report two cases, each, three surgeons report three cases each and one surgeon reports the largest number in the group—a series of four cases with only one recovery.

The most striking and outstanding fact gathered from the tabulation of these reports, is the continuous improvement in the operative results obtained in the last five years as compared with those in the early cases. Whereas prior to 1922, only thirteen successes could be obtained out of a series of forty-five cases, in our collected series of thirty-seven cases, there are eighteen complete recoveries. In three other cases, there was complete circulatory restoration of the part, but with subsequent death of the patient, as a result of secondary emboli that lodged in other parts of the body. In two additional cases there was partial restoration of circulation with resulting limitation of the gangrene. Death followed the operation in fourteen cases. This gives us 50 per cent. complete recoveries, 5 per cent. improvement, 8 per cent. operative recovery with subsequent death and 37 per cent. operative mortality. (Chart 2.) Most of the recoveries were obtained where the operation was performed very early. (Chart 3.)

CHART 2

## Results of Embolectomy

Complete recovery .....	18
Complete circulatory restoration subsequent death.....	3
Partial circulatory restoration limitation of gangrene.....	2
Immediate gangrene and death .....	14

# MAX DANZIS

## CHART 3

### *Analysis of Results*

Based on Time Element

	Time elapsed						
	Less than 4 hours	4-8 hours	8-12 hours	12-18 hours	18-24 hours	Over 24 hours	Not given
Complete recovery.....	4	5	2	1	3	1	2
Circulatory restoration subsequent death.....	1	2	0	0	0	0	0
Partial success gangrene limited.....	1	0	0	0	1	0	0
Deaths.....	4	2	2	4	0	1	1

The occurrence of emboli is more frequent in women than in men. Age is a very important factor. Most of the cases occur either in late middle life or old age. Cardio-vascular disease is given as the etiological factor in twenty-two cases, parturition and surgical operations in nine, and in six cases the causes are not given. (Chart 4.) The location of the emboli were mostly in

## CHART 4

### *Analysis of Results*

Based on Etiology

Post-operative .....	6 cases
Deaths .....	2
Complete success .....	3
Partial success, gangrene limited .....	1
Parturition complicated by cardio-renal disease .....	3 cases
Deaths .....	1
Complete success .....	2
Cardio-vascular disease .....	22 cases
Deaths .....	7
Complete circulatory restoration, subsequent death.....	3
Complete success .....	11
Partial success, gangrene limited .....	1

the lower extremities, twenty-six out of thirty-seven. The femoral artery predominated. Those in the upper extremity usually lodged either in the axillary or brachial artery. (Chart 5.)

## CHART 5

### *Location of Embolus*

Upper extremity .....	11
Axillary artery .....	5
Subclavian artery .....	1
Brachial artery .....	5
Lower extremity .....	26
Bifurcation of aorta .....	2
Femoral artery .....	18
Iliac artery .....	4
Popliteal artery .....	2



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It is interesting to note that no secondary emboli appeared in those cases that occurred post-operatively or following parturition. Of the nine cases falling in this category, we have five successful results, one partially successful (limitation of gangrene) and three deaths. In the twenty-two cases listed under cardio-vascular disease, we find three complete post-operative circulatory restorations with death following several days later as a result of secondary emboli.

There is one case of complete recovery following the removal of a septic embolus several days after an operation for suppurative appendicitis. (Chart 6.) This would indicate that the operation may be justified even in those who are suffering from septic diseases. The generally accepted opinion, however, is that the operation is contra-indicated under such circumstances.

CHART 6  
*Types of Operation Followed by Embolus*

Operation	Location of embolus	Time elapsed	Result
Thyroidectomy.....	Femoral	45 min.	Death
Hysterectomy.....	Femoral	15 hours	Death
Cholecystostomy.....	Subclavian	5 hours	Success
Herniorrhaphy.....	Axillary	2½ hours	Success
Appendectomy (suppurative)....	Brachial	3½ hours	Partial success
Not given.....	Femoral	19 hours	Success

### CASE REPORTS

CASE I.—R. S., female, age fifty-eight, with a history of diabetes of several years' duration. Thirty-six hours previous to admission to the hospital patient experienced a sudden pain in the forearm with numbness and tingling of her fingers. The left hand became pale and livid, and pain became progressively worse.

On admission to hospital the patient appeared quite ill, markedly emaciated, and in much pain. The right upper extremity was somewhat cyanosed but the pulse was felt. The left arm was warm, the brachial artery was palpable and pulsated to about the upper third of the arm. Below this point no pulsation was felt. At the point where the pulsation ceased, the artery seemed to be somewhat dilated. The consistency at this point was that of a hard fibrous cord. A distinct nodule could be felt apparently within the lumen of the artery. Below the elbow, the skin was of an ashen-gray color and very cold to touch. The fingers of the left hand were held in a flexed position—(claw shaped). The entire forearm was painful and motor function was impaired. A diagnosis of embolus of the left brachial artery was made and immediate operation was performed.

Under brachial plexus block anæsthesia an incision about 15 cm. long was made on the inner aspect of the left arm. The brachial artery was isolated and lifted from its bed, from the profunda brachialis down to the elbow. The embolus was easily palpated within the lumen of the vessel and could be dislodged in an upward and downward direction with ease. Two tapes were applied at points above and below the obstruction and the artery incised directly over the clot and the embolus evacuated. Blood flowed freely from the proximal portion of the vessel. The portion of the vessel below the incision was milked upward and an elongated thrombus was expressed through the incision. There seemed to be an extensive thrombosis of the vessel down to and below the bifurcation of the brachial artery. After the thrombus was expressed from the vessel,

a ureteral catheter was passed through the incision into the vessel distally and no obstruction was met. Irrigation with citrate solution was not done for fear of driving small fragments of the thrombus into the lowermost branches of the radial and ulnar arteries. The incision in the artery was closed with vaselined silk and the soft parts closed with layer suture. The patient was in poor shape throughout the operation. I am unable to state definitely the probability of reestablishment of circulation in the arm, because the patient died suddenly six hours later with signs of cerebral embolism.

CASE II.—R. G., age seventy. Admitted to the hospital December 12, 1926. This patient had suffered from endocarditis and myocarditis for many years. With the exception of occasional respiratory difficulty, she felt well until five hours before admission when she felt a sudden sticking pain below the right shoulder radiating down to the elbow and to the finger tips. This pain became constant and increased in severity. The patient stated that the entire extremity felt numb and that she was unable to move the arm for one hour. The pain later on diminished slightly and there was a gradual return of motive power to the arm.

On admission to the hospital the right forearm, hand, and fingers appeared to be distinctly cyanosed. The extremity was definitely colder to touch than the opposite arm. No pulse was felt at the wrist, ante-cubital fossa, or along the course of the brachial artery. Some pulsation could be felt in the apex of the axilla and distinct pulsation in the supra-clavicular fossa. The patient appeared moderately shocked and complained of a great deal of pain in the affected arm with some impairment of motion. The diagnosis of axillary thrombosis was confirmed and immediate operation advised.

Under brachial plexus block anæsthesia a longitudinal incision was made over the inner surface of the upper portion of the right arm exposing the axillary space with its contents. The axillary artery was isolated but no pulsation was felt at the level of the head of the humerus. The outer border of the pectoralis major was split across in order to reach the second portion of the axillary artery, above which pulsation could be felt. The clot was located at this portion of the artery. The usual method of procedure was followed in the operative technic, and a bean-shaped clot about one-half inch in length, thick enough to completely block the vessel, was removed. The portion of the vessel distal to the incision was milked upward in order to express any portion of the thrombus which may have formed below the embolus, but none was found. When the clamp proximal to the arteriotomy was released there was a free arterial spurt synchronous with the pulse. The wound in the artery was closed with vaselined silk. After closure of the wound, a feeble pulse could be felt in the ante-cubital fossa, but no radial pulse.

The patient reacted well from the operation and the following morning the extremity was warm. Still no radial pulsation. Has dissociated sensation but full motion. Arm kept warm by electric baker.

December 8. Cyanosis disappeared. Visible improvement but no pulse at wrist.

December 10. Brachial pulse felt. Arm warm. Cyanosis entirely gone. Full motion. Sensation same.

December 13. Radial pulse felt. Circulation apparently fully restored. Patient able to raise arm at right angle to body. Normal function in hand and forearm. Wound dry and clean. Sutures removed. General condition very good.

Two days later, that is, ten days following the operation, while the patient was lying in bed, she felt a sudden coldness on the plantar surface of the right foot. This was followed immediately by a sharp pain in that area. Two hours later the pain became much worse and there was a beginning lividity of the toes, particularly the nails. Pulsation in the right femoral below Poupart's was felt, but no popliteal pulsation could be felt. There was marked tenderness over the right Hunter's canal, but no tenderness in Scarpa's triangle or popliteal space. A diagnosis of embolus of the lowermost portion of the femoral or beginning popliteal artery was made and operation performed two hours after the onset of the first sign.

Under spinal anæsthesia, an incision was made over the inner surface of the thigh

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following Hunter's canal toward the popliteal space. The lower portion of the femoral and the upper part of the popliteal artery was isolated and a large clot was removed from the upper segment of the popliteal artery. Another incision was made lower down and the segment of vessel included between the two incisions was flushed with saline solution. Both arteriotomy wounds were closed in the usual manner. Pulsations were visible after closure below the obstructed point.

The following day, the lower third of leg and foot assumed a discolored and mottled blue appearance. No pulsation or sensation. Arm wound, however, was clean and the entire upper extremity in perfect condition. On the third day dry gangrene of the leg was definite and amputation above the knee under spinal anæsthesia was performed on the fourth day. Patient died on the following day.

Dissection of the vessels from the leg showed the femoral artery and profunda femoris to be free and clear. The popliteal artery was patent and showed no evidence of any pathological changes, aside from some slight atherosclerosis. At the bifurcation of the popliteal into the anterior and posterior tibial arteries, was a saddle embolus composed of a white thrombus distal to which ran a secondary red thrombus for a few inches. Below this the arteries were empty and aside from slight atherosclerosis showed no obstruction of the lumen.

Evidently another embolus or part of the same one was overlooked at the bifurcation of the popliteal artery. In this case I should have done an arteriotomy on the anterior and posterior tibial to rule this out and possibly dislodge the clot by retrograde catheterization.

### CONCLUSIONS

1. Embolectomy is assuming a definite place as a surgical therapeutic measure in cases of sudden circulatory obstruction, especially in arteries of the extremities.

2. Early diagnosis and prompt surgical measures are essential for successful results.

3. The operation should be done under regional or spinal anæsthesia.

4. Careful search should be made for obstructive emboli or thrombi above or below the primary embolus before the artery is closed.

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# ILEOCÆCAL ENTEROCYSTOMA PRODUCING PARTIAL INTUSSUSCEPTION \*

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ENTEROCYSTOMATA of the ileocæcal valve are of interest to the surgeon because of their rarity, mode of origin, location and clinical manifestations of intestinal obstruction. Some question might arise as to whether this group of unusual tumors of the bowel should not belong to Dowd's<sup>1</sup> original classification of mesenteric cysts of enteric origin. Prior to the publication of his article in 1900, Hahn (1887),<sup>2</sup> Braquehay (1892),<sup>3</sup> as well as Moynihan (1897),<sup>4</sup> omitted cysts of this type from their classification entirely. However, with Roth,<sup>5</sup> Colmer,<sup>6</sup> Kaufman<sup>7</sup> and most others,<sup>8, 9, 10, 24</sup> ascribing the origin of mesenteric cysts to faulty or incomplete involution of the omphalomesenteric duct, there should be no difference between cysts of similar structure whether they occur within the layers of the bowel wall as is seen in our case or whether they occur within the mesentery or omentum. Moynihan,<sup>4</sup> in 1897, found altogether one hundred cases of mesenteric cysts in the surgical literature. Swartley,<sup>11</sup> in a recent article, states that at the present time there are two hundred cases of these cysts which have been found within the mesentery itself, and about an equal number of similar structure occurring in the omentum.

Enterocystomata are among the most uncommon of the mesenteric cysts. Colmer, in 1906, collected thirty-nine cases; four within the abdominal wall, twenty along the free convexity of the bowel, and fifteen in the mesentery. MacAuley (1924),<sup>12</sup> in a most comprehensive article, reviewed and abstracted twelve cases of enteric cysts occurring in the region of the ileocæcal valve. Aschner,<sup>10</sup> in the same year, reported the abstracts of six additional cases and five more isolated cases have been collected. As might be expected, a number of these twenty-two cases are so inadequately described that there is some doubt as to whether they should be included. Still it is reasonable to assume that the same proportion of reports included in Swartley's figures are unreliable. With mesenteric cysts in general, being among the pathological rarities, enterocystomata of the ileocæcal valve as a cause of intestinal obstruction is practically unknown. This is attested by the fact that they are either omitted entirely or are scarcely mentioned in the standard surgical or pathological text-books. Although enterocystomata occur anywhere throughout the intestinal tract or remains of the omphalomesenteric duct, only those twenty-two cases reported as found in the region of the ileocæcal valve were here considered because of their similarity to the case we are reporting. No new case has been published since 1925.<sup>20</sup>

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\* Read before the Chicago Surgical Society, December 6, 1927.

## ILEOCÆCAL ENTEROCYSTOMA

That these cysts are of congenital origin cannot be questioned. In this group of twenty-two cases, fifteen were found either in the newborn or in infants under one year of age. The majority were discovered at autopsy.

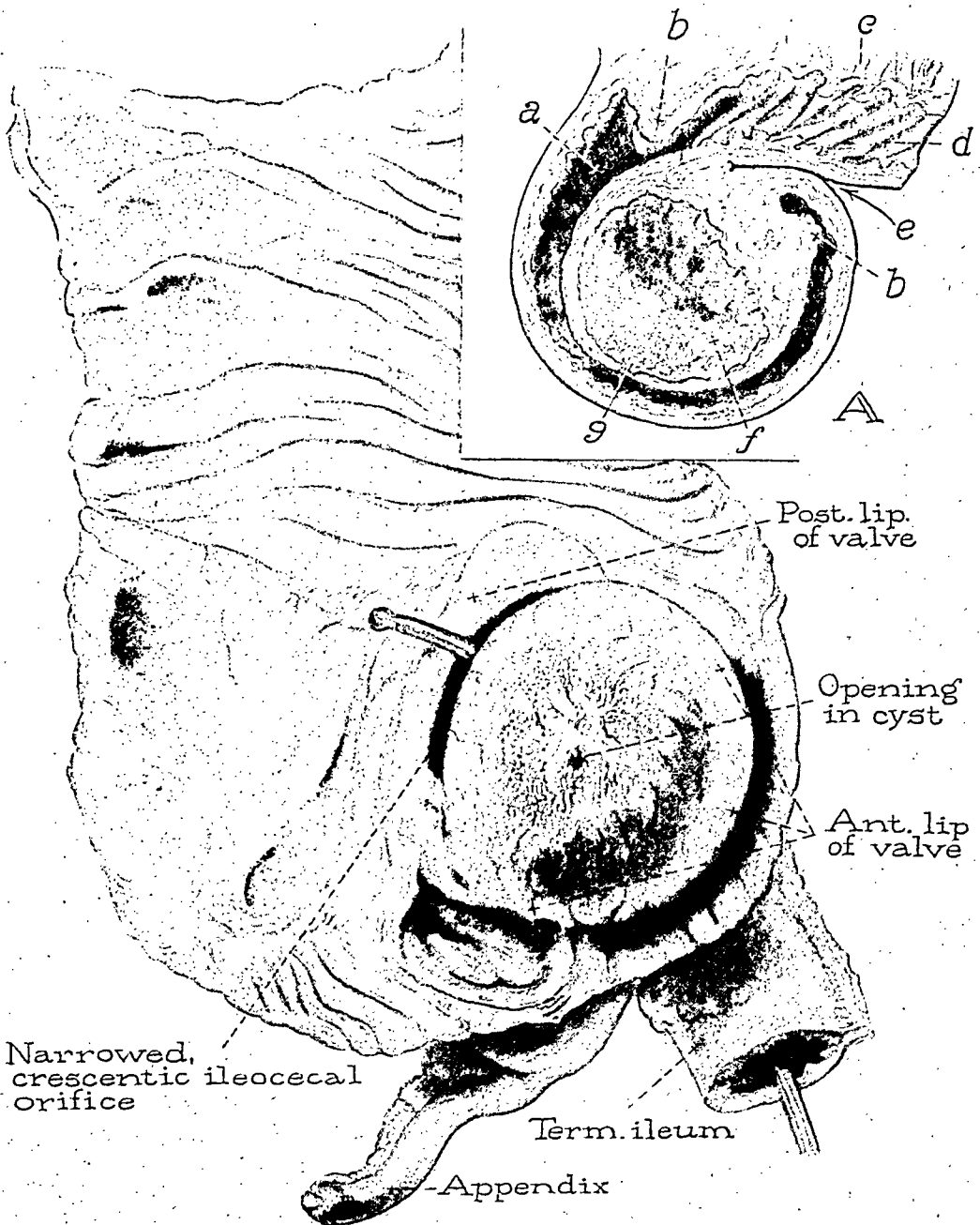


FIG. 1.—Enterocystoma of the terminal ileum protruding through the ileocæcal valve with the cæcum and ascending colon layed open. A, Cross-section horizontally through the cæcum and the ileum; *a*, cavity of the cæcum; *b*, anterior lip of the valve; *c*, mesentery of the ileum; *d*, normal ileum; *e*, peritoneal pocket formed by the partial intussusception of the ileum into the cæcum; *f*, cavity of the cyst; *g*, opening in top of the cyst.

The few cases that persisted to adult life <sup>18, 21, 22, 27, 28</sup> all had recurrent symptoms of right lower quadrant disturbance. For the most part the symptoms dated back to infancy or at least for a number of years. Ayer's <sup>18</sup> patient was twenty-three years of age and the complaints were present for seven

years. His is the oldest authentic case on record and is almost identical in every respect to our own. Our case, however, differs in that it did not have any previous symptoms. The delayed occurrence of serious trouble may have been due to the presence of a communication between the cyst and the lumen of the bowel. This permitted free drainage of the mucous secretions and thereby prevented retention and further enlargement of the cyst. The resulting accumulation of fecal material passing into the cyst eventually predisposes to infection, swelling and ultimate obstruction.

*Mode of Origin.*—Because of their location most authors attribute the development of enteric cysts to faulty involution or malformation of the omphalomesenteric duct. This is due to the fact that no other embryological structure had been demonstrated which could contribute to their formation. Both the faulty involution and the malformation must play important rôles if one is to consider their congenital origin and distribution. A normally placed duct with faulty involution would predetermine the location of any developmental defects. The duct has been found to connect with the ileum anywhere from four to fifty-seven centimetres from the ileocaecal valve. This makes a wide distribution of the cysts possible but it does not account for those which occur within the caecum. Baldwin,<sup>13</sup> Lotheisen,<sup>21</sup> and Blackader<sup>14</sup> reported enterocystomata of the caecum occurring opposite the ileocaecal valve. Although atypical, because of the location and inability to develop from the omphalomesenteric duct, they may be included as enteric diverticular cysts of embryonic origin as originally described by Shallow.<sup>15</sup>

Other less founded and more theoretical hypotheses have been expounded to account for their formation. Sir Arthur Keith<sup>16, 17</sup> found an enteric cyst in the mesentery and thought that it probably had its origin there. He states that this "shows the original site before they change their position as a result of growth expansion." Ayer<sup>18</sup> and Turner and Tipping<sup>19</sup> held similar views. Sequestration, inclusion, or the snaring off of portions of the embryonal gut has been held responsible for the formation of these enteric cysts by Dowd, MacAuley, Blackader, and others.<sup>20, 18, 21, 22, 23</sup> All the cases of enteric cysts can now be explained on the following embryological bases as first suggested by Shallow.<sup>15</sup>

Embryological intestinal epithelium as found and reported by Keibal and Mall<sup>25</sup> is seen to contain numerous "vacuoles." "In embryos of 6.5 to 7 mm. the duodenum usually presents a well-defined round lumen, bounded by a two- or three-layer epithelium. In slightly older embryos the epithelium proliferates, and vacuoles are found within it, especially on the dorsal and right side of the tube. Later the proliferating epithelium bridges and subdivides the original lumen . . ." The lower portion of the small bowel never presents a subdivided lumen such as is found in the duodenum, but its epithelium contains scattered vacuoles, which develop in a very characteristic manner. These "vacuoles are indistinguishable from the main lumen" and occur anywhere along the intestinal tract or the omphalomesenteric duct since, early in fetal life, the entoderm of the primitive gut is continuous

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throughout the duct to the abdominal wall. Since the structure of the walls of the enteric cysts are, for the most part, exact replicas of the normal intestinal structure, this makes it significant to find such embryonal developments indistinguishable from the main lumen. As the formation of the intestinal tract develops in the fetus the vacuoles disappear. It is reasonable then to assume that these embryonal vacuoles, which are indistinguishable from the main lumen, might remain to become the anlage of the enterocysts which are of exactly similar structure to that of the adult intestinal wall.

These vacuoles occur "chiefly along the portion of the intestinal tract found within the umbilical cord, or situated along the convex surface of the intestinal coils, opposite the mesenteric attachment." This brings out the fact that there is some relationship of the enteric cysts to the omphalomesenteric duct and confirms the pathological findings in the cases reported. It places them on a less theoretical basis as to the malposition of the duct being completely responsible for the wide distribution of the cysts. In our case, as in most of the others, the cysts were found on the convex portion of the free surface of the ileum. On the other hand, the relative frequency of occurrence of these vacuoles in the duct and various parts of the intestines predetermines the probabilities of the location of the adult cyst. Therefore, with decreasing frequency, they are found along the remains of the duct, to the ileum and then ascending to the duodenum.

Multiplicity of these cysts is to be expected if one is to consider their



FIG. 2.—Microphotograph of the section through the base of the cyst, showing (a) the muscularis mucosa of the lining of the cyst; (b) the mucosa with the simple tubular glands and villi; (c) submucosa; (d) mucous membrane covering cyst exactly similar to that lining the cyst; (e) longitudinal muscular layer; and (f) a plica circularis of the terminal ileum protruding with the cyst through the valve.

origin in the numerous embryonal vacuoles. Strode and Fennel,<sup>23</sup> in 1923, reported in a most complete description the presence of two enterocysts found in a newborn. The larger one occurred in the ileum and the other, completely separate, lying within the mesentery. Hueter's<sup>26</sup> case, although not so completely described, also had two cysts of enteric structure.

Clinically, these cysts, when occurring within the wall of the intestines, are interesting because of their mechanical interference with bowel function. Obstruction is produced either by the size of the tumor encroaching on the lumen of the bowel or as a stimulus to hyperperistalsis resulting in intussusception which most frequently occurs. Since the symptoms usually develop soon after birth, the diagnosis is almost invariably intussusception. With the picture of intestinal obstruction and a palpable mass in the right lower quadrant in an infant, the case is classical. In the few older cases, appendiceal abscess, malignancy and hyperplastic tuberculosis were considered. In no case was the true condition thought of until after thorough exploration at operation or examination of the pathological specimen was made. Eleven of the twenty-two cases of cysts of the ileocaecal valve came to operation. Five of seven resections with lateral anastomosis recovered and in two others local excision was done with uneventful recovery. Enterostomy and ileostomy were performed in the two other cases to relieve the obstruction, but the efforts were futile because of the moribund condition of the patients.

#### CONCLUSIONS

Enterocystomata are of the rarest type of intraperitoneal tumors.

They are congenital in origin.

They develop from embryological structures which are indistinguishable from the main lumen of the embryonic intestinal canal.

They may be multiple.

They produce intestinal obstruction.

Resection of the cyst-containing portion of the bowel or, in some instances, local excision is necessary to relieve the obstruction.

#### CASE HISTORY

The patient, a white male, age twenty-six, lawyer by occupation, enjoyed perfect health until two weeks prior to admission to the Presbyterian Hospital, on the service of Dr. D. B. Phemister. There had been a gradual onset of the present condition with generalized abdominal pain at first, and slight cramps which soon became severe. At the time of admission to the hospital, the attacks of cramps were associated with marked soreness, tenderness and gurgling sounds throughout the abdomen. These attacks, although distressing from the beginning, became more frequent in occurrence and of longer duration. Inaugurated by eating, especially greasy foods, moving about, or drinking cold beverages, definite relief was obtained by taking soda, milk of magnesia as a cathartic, by bowel movements induced by enemas, or with the use of an electric pad. Remissions would be only temporary. However, at the time of admission, cathartics and enemas very definitely aggravated the cramps. Bowel movements, even with stimulation, had become increasingly smaller in amount though the color and consistency remained apparently normal. No blood or tarry stools had been noticed.

For the first five days after the onset of the present condition the patient was confined to bed. Although there had been no improvement during this time, he returned



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to his office and, with the added exertion, the cramps became more severe and frequent until he found it impossible to complete his second day and was forced to return home. A physician was then called who prescribed some pills which eased him temporarily, except that the soreness and tenderness continued to increase in severity. Toward the end of the second week of the illness, the localizing complaints led to the finding of a firm movable, tender mass in the right lower quadrant. At the same time the patient had noticed that the severe cramps across the lower abdomen were associated with loud gurgling sounds. No distention of the abdomen or other unusual findings were observed. No nausea, vomiting, anorexia, or fever had been noticed.

On admission into the hospital, the patient appeared to be in good physical condition and not acutely ill. The soreness and the tenderness in the right lower quadrant were localized to a firm, egg-sized, movable mass in the upper part of the quadrant mesial to the cæcum. Slight distention with faint peristaltic waves was visible over the lower central portion of the abdomen. No increased peristaltic sounds could be detected, however, even during the height of distress. The entire large bowel was palpated as a firm cord suggesting an empty spastic condition. Fluoroscopy and plates (Fig. 3) revealed a filling defect about the size of a hen's egg, on the mesial side of the cæcum where the mass was palpated. Examination of chest, heart, and remainder of body was negative. Urine and stools were repeatedly negative (no blood, etc.). White blood-cells 8050; hæmoglobin 87 per cent.; blood-pressure 126/74.

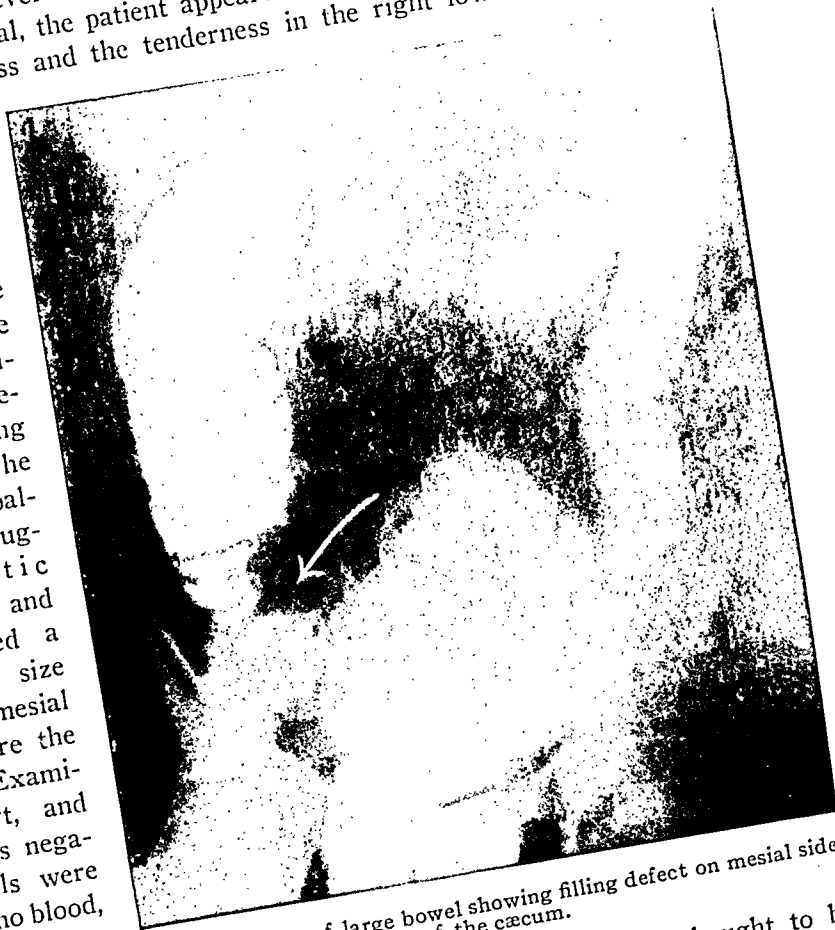


FIG. 3.—X-ray of large bowel showing filling defect on mesial side of the cæcum.

With the above history and fluoroscopic findings the condition was thought to be very likely appendicitis with abscess formation or possibly a mucocoele of the appendix. Malignant tumor of the cæcum or enlarged lymph-glands were also considered.

*Operation.*—Through a right lower rectus incision the cæcum, ascending colon and the terminal ileum were delivered and examined. Because of the regional glandular enlargement, malignancy or hyperplastic tuberculosis of the cæcum was first considered. The presence of a large calcified gland made the latter more likely.

Resection of the cæcum, terminal ileum and ascending colon was decided upon. The mesentery being fairly long, a V-shaped excision of the terminal ileum to the transverse colon followed. Lateral anastomosis of the terminal ileum to the transverse colon was done. The post-operative convalescence was uneventful.

*Pathological Report.*—The specimen consists of the cæcum, ascending colon and the distal three centimetres of the ileum with the appendix and mesentery. Within the attached portion of the mesentery, there are three large, almond-sized, firm lymph-glands. One gland is yellow-gray and very hard, and on cutting, it was found to be calcified.

Externally, the anterior and mesial part of the cæcum surrounding the ileocæcal junction is markedly swollen and hyperæmic. The swelling projects and overlies the terminal ileum, forming a pocket two centimetres in depth, giving the appearance of intussusception. It cannot be reduced by traction on the ileum. Posteriorly, however, the peritoneum of the cæcum and ileum is normally flush and continuous. No adhesions are present either within the peritoneal groove or anywhere on the surface of the specimen. The appendix is of normal size and consistency and is not injected. The remainder of the specimen is entirely normal.

Within the cæcum there is palpated a firm, smooth, apricot-sized, fixed, globular mass attached to the site of the external swelling of the cæcum. The lateral wall of the cæcum is freely movable over the mass. There is no dilatation of the ileum and its walls are of normal thickness. Viewing the lumen of the cæcum through the cut end of the colon, a dark red, round tumor is seen to fill the cavity almost completely. (Fig. 1.)

The cæcum and colon are opened along the lateral margin. The lining of the bowel is normal. A globular tumor mass, four centimetres in diameter, is present on the lower and anterior part of the ileocæcal valve which is thinned out and everted by the apparent protrusion of the mass through the valve. The remainder of the ileocæcal valve is normal and uninvolved. The tumor is soft and definitely cystic. It is attached by almost its full diameter, proximal to the valve and within the terminal ileum itself. The lumen of the orifice is narrowed by the overhanging mass which gives it a very narrow crescentic shape. A free communication between the ileum and the cæcum is present when both are empty. There is a small opening, 0.3 centimetre in diameter, on the top of the cyst which leads into the cavity.

Upon opening the cyst, a large, firm, dark brown fecolith is found completely filling its cavity. Normal appearing mucous membrane lines the cyst except at the top where it is thin and flattened. The cyst wall is unusually thick at its base, measuring six millimetres. No areas of necrosis are seen. Nowhere are the layers lining the cyst continuous with those of the bowel wall.

*Histology.*—(Fig. 2.) Microscopic sections of the wall of the cyst shows two layers of small intestinal mucous membrane; one lining the cyst and the other covering it. Simple tubular glands which do not penetrate through the muscularis mucosa are seen in both (glands of Liebkühn). Cylindrical, foliate, or club-shaped elevations of the epithelium and tunica propria (villi) are present and at the base of the glandular depression there are numerous coarsely granular cells (cells of Paneth) characteristic of the mucous membrane of the ileum. At the junction of the cyst and the ileocæcal orifice, there is a valvula connivens with a good-sized projection composed of the entire mucous membrane and submucosa. The difference in thickness between the mucous lining and covering of the cyst is probably due to the plane in which the sections were cut.

A thick layer of longitudinal muscle is present. Bundles of circular muscle fibres are only seen at the base. Pressure atrophy must account for the slight difference in structure seen at the base and the top.

There is a thick layer of submucosa especially toward the apex. Within it there are numerous blood-vessels, lymph spaces, and lymph follicles. Marked round-cell infiltration is seen at the base of the cyst. Microscopic section of mesenteric gland.

After decalcification of the calcified gland, section shows a small area of normal lymphoid tissue. The majority of the gland is occupied by dense hyaline connective tissue, surrounding plaques of previously calcified tissue. No evidence of tubercle formation or giant-cells is present.

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# SUBLINGUAL PHLEGMON

PRIMARY AND SECONDARY LUDWIG'S ANGINA

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SUBLINGUAL phlegmon is a malady of major surgical importance which is found the dominating symptom of primary or classical Ludwig's Angina. It is also seen as the outstanding feature of another group of infections about the neck which in the literature and in the clinic have been erroneously grouped with Ludwig's Angina on the strength of possessing this one symptom. The confusion that this has created has led us to set apart this latter group of cases under the name of Secondary Ludwig's Angina. The disease which has been so set apart under Ludwig's name has been defined with unmistakable clearness in Foster's Encyclopædic Medical Dictionary as "a diffuse phlegmonous inflammation of the floor of the mouth and the intermuscular and subcutaneous tissue of the submaxillary region which may end in gangrene, abscess, or resolution, and which sometimes prevails in an epidemic." The term infectious has only to be added to make this definition complete. It is a relatively uncommon disease among the great number of infections which are found occupying similar areas and presents a fairly constant and clear picture both clinically and pathologically. Yet as one scans the literature on this subject for the past few decades, it is all too evident, what a catch-all this term has been for many of the infections about the mouth and tissues of the neck, pharynx and larynx, which bear little or no resemblance to true Ludwig's Angina. The explanation is not difficult. There is among all these infections, as we have just stated, a very definite group of cases which, at some period in their course, present the cardinal symptom of true Ludwig's Angina, *i.e.*, sublingual phlegmon. One or more, or all of the other attributes of the disease described by Ludwig, may be lacking. Moreover the sublingual phlegmon itself may be from quite a different focus, of a different nature and significance from that in the classical Ludwig's Angina. A generous inclusion of these infections with that common symptom under the one head has undoubtedly been the cause of much of the confusion regarding the disease. This in turn has led to inadequate standardization of the surgical treatment and to misconceptions regarding the clinical course and prognosis. We particularly wish to deal with this atypical non-conforming group of cases—the secondary Ludwig's Anginas, and also to emphasize the need of early radical surgical treatment in all cases showing this serious and most distressing symptom.

*Historical.*—Among the earlier medical writers, Aretaeus,<sup>1</sup> in his chapter

on Angina and Quinsy, clearly describes a malady in its advanced state that modern writers have interpreted as undoubtedly the same as that which now bears Ludwig's name. He says, "Cases of cynanche are attended with inflammation of the tonsils, of the fauces, and of the whole mouth; the tongue protrudes beyond the teeth and lips; they have salivation, the phlegm running out very thick and cold; they have their faces ruddy and swollen; their eyes protuberant, wide open, and red; the drink regurgitates by the nostrils. The pain is violent but obscured by the urgency of suffocation. The chest and heart are in a state of inflammation. In certain cases there is a ready transference of the disease to the chest and these die from their metastases. . . . But if in any case there is a turn to the better, abscesses form on either side, near the ears externally, or internally about the nostrils. . . . This species is called cynanche, either from its being a common affection of those animals or from its being a customary practice for dogs to protrude the tongue even in health."

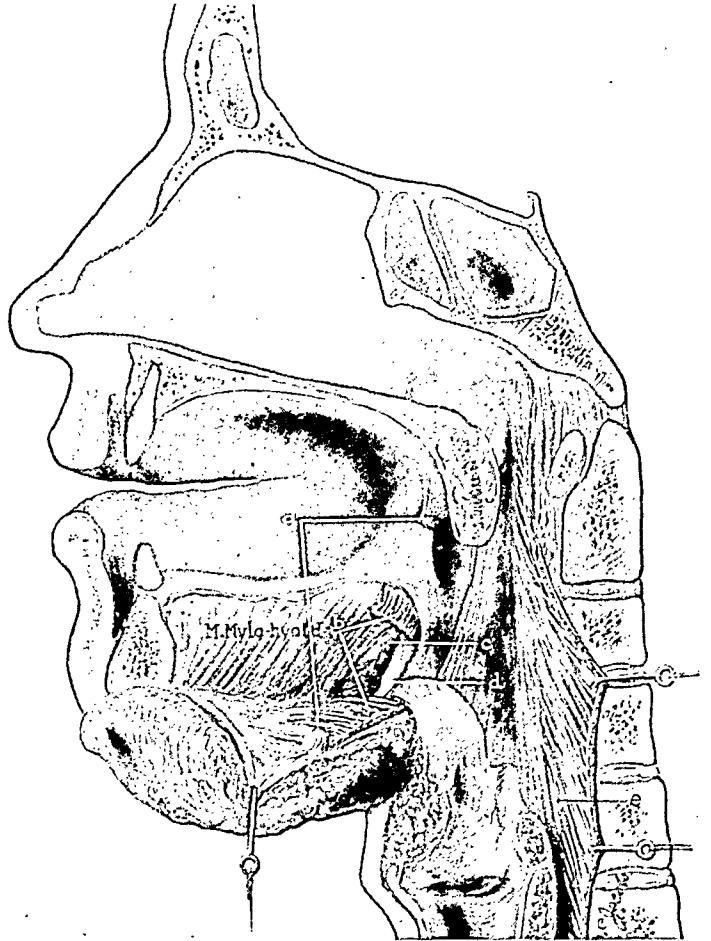


FIG. 1.—Dissection of floor of mouth and pharynx and larynx. In the dissection of a median sagittally divided head and neck, the mucous membrane of the floor of the mouth near the alveolar margin was first divided. The tongue was then turned completely over by first dividing the palatoglossus (*a*) and next the styloglossus muscles (*b*). The hyoglossus muscle was left intact. The muscles of the pharynx and lateral side of the larynx were then exposed, especially to show the close relationship of the middle constrictor (*3*) to the submaxillary gland (*c*) which curls about the posterior border of the mylohyoid muscle. The space (*d*) between the submaxillary gland and the middle constrictor muscle of the pharynx is filled with loose connective tissue.

Paulus Aegineta<sup>2</sup> in his discourse on Angina or Quinsy refers to it as a paracynanche and recognized the danger of the sublingual affection. His treatment, while inadequate, nevertheless contains certain principles of worth. "In others we must immediately bleed from the arm; and take away not a great quantity at once, but in divided quantities—should they not be immediately relieved by it we must open the veins below the tongue or make incisions in the tongue itself, if it be swollen or protrude out of the mouth."

Wells,<sup>3</sup> in 1809, and Gregory,<sup>4</sup> in 1822, each reported a case record with necropsy findings that was without doubt a "Ludwig's Angina". It

remained for D. Ludwig,<sup>5</sup> however, in 1836, to describe in detail this "gangrenous induration of the neck" with completeness that has left little but emphasis to be added by succeeding writers. A year later Camerer described one of these cases and gave to it the name by which it has come down to us—Ludwig's Angina. Since this time there have been several notable contributions to the subject, particularly by Parker,<sup>6</sup> Newcombe,<sup>7</sup> Hamann,<sup>8</sup> Thomas<sup>9</sup> and others.

*Nomenclature.*—However inappropriate the term "Ludwig's Angina" may be considered to be and although one may object to it on the grounds of priority of description, its accorded place on the medical page of all countries for well nigh a century precludes its being readily supplanted by a descriptive anatomical term, however apt. Neither does the loose usage of the name and the widespread tendency to include under this term forms of infection failing to coincide with Ludwig's original description at once warrant its being discarded. Moreover, it scarcely seems helpful to describe under an entirely new and unfamiliar name these atypical cases whose claim, if any, to the name rests on their possession of the one cardinal symptom—sublingual phlegmon. Rather, we believe the whole subject may be clarified by a classification of these cases into a group which is to be known as Secondary Ludwig's Angina. Those which coincide with the original description may well be known as Primary Ludwig's Angina.

It may best serve our purpose to turn first to a consideration of the true or primary angina of Ludwig after which variations from it can better be understood.

*Primary Ludwig's Angina.*—Primary Ludwig's Angina when seen in the fully developed state is unmistakable. The features of the disease which Ludwig most emphasized and by which it is still known are:

1. A primary slight inflammation of the throat, which if present disappears in a day or so, or, if persistent may be considered as of secondary diagnostic importance.

2. A wood-like brawny condition of the connective tissue involved about the submaxillary gland.

3. A hard swelling beneath the tongue with a raised, stiff swelling of the floor of the mouth of a deep red or bluish-red color.

4. A uniform spread of the inflammation that is always sharply bordered by a zone of healthy tissue.

5. Failure of the lymph-nodes to be involved although their cellular tissue-surroundings may be affected.

Of these symptoms of primary Ludwig's Angina sublingual phlegmon is of paramount importance from the point of view of the clinician, and also to those who seek a standard of comparison whereby phlegmon having different characteristics may be compared, separated, and further classified. The sublingual phlegmon of primary Ludwig's Angina has very definite characteristics and in their absence a diagnosis cannot be made. *It is on the different immediate sites of cervical infection which may give rise to this dominating*

## SUBLINGUAL PHLEGMON

symptom—sublingual phlegmon—on the different paths over which the sublingual tissues become infected, and on the different relationships which this phlegmon bears to the whole mass of infection that ample means and reason exist for dividing these cases into two groups as we have proposed.

First, all writers agree that the sublingual phlegmon in true or primary Ludwig's Angina arises primarily from the region of the submaxillary gland. Teeth, tonsils, breaks in the oral mucous membrane, etc., are the original

portals of entry for bacteria. Difference of opinion exists as to just which structures next become primarily involved in the cervical tissues. Ludwig believed it was the cellular tissue about the submaxillary gland. A number of authors have considered that the submaxillary gland itself was the principal seat of the cervical infection. Roser<sup>10</sup> held it was both. Thomas<sup>9</sup> believed it to be a rapidly spreading cellulitis, beginning in the region of the submaxillary gland as a perilymphadenitis and extending to the floor of the mouth and pharynx. Davis<sup>11</sup> believes it spreads from the

original source by direct extension to neck and sublingual tissues rather than by the lymphatics. We are inclined to think that the tissues involved primarily—perilymphatic cellular tissue, loose areolar tissue, submaxillary gland or lymph-nodes—will not always be the same but will vary occasionally. Unmistakable lymph-node involvement has been observed (Case VIII). Instances of the infection being in the cellular tissues around the lymph-nodes predominate and are probably the rule. We have never observed the cervical infection to be in the submaxillary gland alone.

We believe with Thomas<sup>9</sup> that the cellulitis of the submaxillary region practically always precedes the sublingual phlegmon. He collected eight reports in the literature, three of which were doubtful, where the sublingual seemed to be primary and the cervical cellulitis secondary. In all our cases

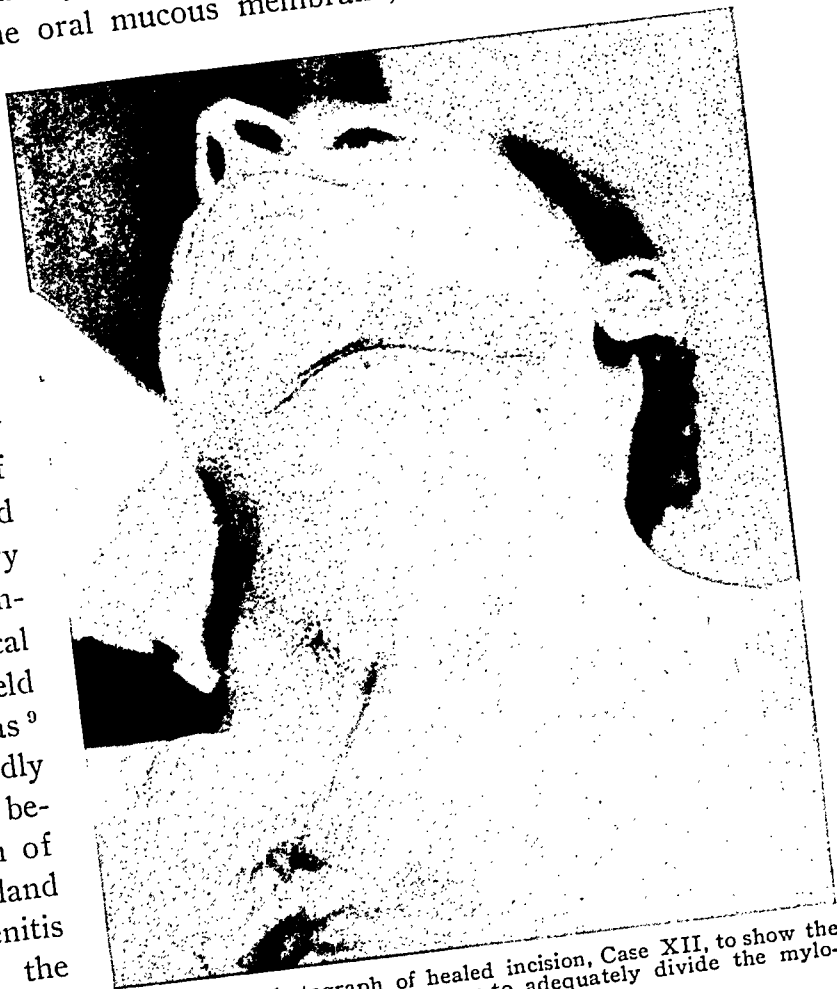


FIG. 2.—Photograph of healed incision, Case XII, to show the length of wound often necessary to adequately divide the mylohyoid muscle.

of primary angina, the cervical infection antedated that beneath the tongue. The sublingual phlegmon, however, follows more closely in the wake of the cervical infection in primary than in cases of secondary Ludwig's Angina.

Second, the path of spread to the sublingual tissues is one of extension around the posterior border of the mylohyoid muscle which makes up the muscular diaphragm of the floor of the mouth. There is usually a small lappet of salivary gland tissue to be found curling about the posterior edge of the muscle as shown in Fig. 1. A ready guide is thus afforded for the spreading cellulitis which is "decompressing" itself medially and upward by extension along the loose cellular tissue planes. Its spread is limited externally by the deep cervical fascia. Once inside the mouth it may spread with ease to the opposite side by following the horse-shoe-shaped cellular tissue arrangement about the anterior part of the tongue. Direct extension across the midline is less common but does occur.

Third, we must look upon the sublingual phlegmon of Primary Ludwig's Angina as part and parcel of a virulent process which has "decompressed" itself by extending medially when limited externally. It is no more severe a process in the sublingual region than in any other sector. Its only claim to special attention is the hazard to life it entails through extension to the larynx and embarrassment of respiration. The predisposition of this phlegmon to break down and form pus is not great but does occur and usually takes place late in the disease, as will be seen in the survey of case records.

The division of cases into a primary and secondary category need not rest alone on the characteristics of the sublingual phlegmon. A critical survey of the less conspicuous symptoms which Ludwig enumerated will also serve to cull from the general group those which strictly do not have a place among the true or primary anginas. Our observations on these lesser features of the disease picture in primary cases can do no more than bear out those set forth by Ludwig. An initial sore throat was complained of in two instances and is not usually an important symptom. The color of the tongue and the sublingual tissues becomes a deeper, more dusky blue as return venous channels are impinged upon by œdema and swelling. While it is true that actual lymph-node involvement about the submaxillary gland is not frequent, it does occur and was observed once. The general woody induration of the cervical tissues usually is present if the case is seen early but with the progress of the disease, œdema of the skin and subcutaneous tissues may obscure it to some extent.

The following are reports of eight cases of Primary Ludwig's Angina which have been in this hospital during the last four years.

CASE I.—Hospital No. 37,791.—*Typical primary Ludwig's angina—secondary to dental sepsis. Operation followed by tracheotomy. Spontaneous opening in the floor of the mouth. Recovery.*

F. S., a girl, thirteen years of age, was admitted complaining of a painful swollen area beneath the right jaw and pain in the region of the right lower first molar tooth. Four days prior to admission there appeared a swelling beneath the right mandible concomitant with an exacerbation of a toothache in the teeth of the right lower jaw.



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The swelling became more marked and so painful that it prevented sleep, rest, or taking nourishment. Two days prior to admission the floor of the mouth began to swell and the tongue was elevated to an extent sufficient to prevent closure of the teeth. On the day of admission difficulty in swallowing became quite marked. A foul discharge of thin fluid was noted to be coming from a tiny opening under the side of the tongue opposite the first molar tooth. The past history is irrelevant except for dental sepsis of long standing.

*Physical Examination.*—The patient presented a classical picture of Ludwig's Angina. There was a hard, tender, slightly red swelling beneath the right jaw extending from the chin nearly back to the angle of the jaw. The teeth were separated and the tip of the tongue protruded from the mouth. Saliva dribbled from the corners of the mouth. The floor of the mouth on the affected side was flush with the teeth. Pressure over the first molar tooth caused pus to exude about it. A fistulous opening was seen in the floor of the mouth opposite this tooth. Swallowing was very difficult. Temperature  $101.2^{\circ}$ , pulse 120, respiration 30, white blood-cells 30,500. An X-ray of the jaw showed an abscess of the first lower molar tooth.

*Operation.*—Under gas-oxygen anaesthesia an incision 6-7 cm. long was made parallel with the ramus of the jaw over the swelling. The mylohyoid muscle was opened in several places without striking free pus. All the structures were brawny and oedematous. A rubber tissue drain was inserted under the mylohyoid muscle beneath the mucous membrane of the floor of the mouth. The tooth was not extracted.

*Progress.*—Immediately following the operation the patient's condition improved. Some ten hours later, however, she became very cyanotic and had great difficulty in breathing. A rapid tracheotomy was done without any anaesthesia. For the next twenty-four hours a stream of oxygen had to be kept playing over the tracheotomy tube at short intervals to allay a fairly marked cyanosis. Aspiration of the trachea at intervals through the tracheotomy tube was also maintained for forty-eight hours, at which time respiration was sufficiently unimpaired to remove the tube. The patient's progress from this point on was steady, though tedious, and complicated by a sequestration of a portion of the right mandible about the abscessed tooth, a severe pansinusitis, bronchitis and otitis media. The carious teeth were removed before discharge.

*Comment.*—This, as will be seen in other instances, illustrates the inadequacy of spontaneous drainage of a sublingual phlegmon into the oral cavity. Removal of the secretions in the trachea by suction through the tracheotomy tube proved to be of very great aid. This procedure, we believe, should always be carried out where a tracheotomy has been done until swelling in the floor of the mouth has subsided sufficiently to allow free expectoration of secretions.

CASE II.—Hospital No. 37,251.—*Primary Ludwig's Angina following extraction of teeth in presence of dental sepsis. Operation. Recovery.*

C. E. M., a woman aged twenty-three years, entered the hospital complaining of a swelling beneath the right jaw. Three days prior to admission she had had twenty-five teeth extracted for an intractable pyorrhœa. Twenty-four hours before admission a swelling below the right jaw was noted and a little later a moderate swelling of the floor of the mouth.

Physical examination showed moderate swelling of the floor of the mouth on the right side and also a swelling beneath the right jaw, extending from the midline to near the angle of the jaw. Temperature  $102.2^{\circ}$  F., pulse 120, respiration 25.

*Operation.*—Under gas-oxygen anaesthesia an incision was made through the right mylohyoid muscle. A small abscess in the submaxillary gland region was encountered and drained. The posterior two-thirds of the mylohyoid muscle was divided.

*Progress.*—Recovery was entirely uneventful and the patient was discharged six days after admission.

*Comment.*—This case affords an example of what we believe to be the rule—that the cervical infection precedes that in the sublingual space.

CASE III.—Hospital No. 37,210.—*Advanced terminal primary Ludwig's Angina. Operation. Fatality.*

E. S., a fifty-four-year-old male, entered the hospital complaining of marked swelling about the right jaw, the right side of the face, and also the left neck.

The past history is irrelevant except for a similar though much less severe swelling about the right jaw two years ago, which lasted two days and subsided spontaneously. He had had many neglected carious teeth for years.

Nine days previously he noticed a swelling about the angle of the right jaw. The swelling became progressively worse and in two days' time involved the whole side of the face and neck and had spread over to the left side. At the end of the second day he began to apply poultices and continued up to the time of admission without improvement. Speech became impeded for the last three days and swallowing became progressively more difficult from the onset of disease. He was seen by three physicians before being advised to have immediate surgical intervention.

*Physical Examination.*—The patient was a desperately ill adult male, who was having difficulty in swallowing and slight difficulty in breathing. The whole right side of the face and neck was swollen, red, and œdematous, from the eyebrow to the clavicle. The left side of the neck was swollen and œdematous but less than the right. The tongue was bluish, swollen and elevated nearly to the palate, and the floor of the mouth on the right side was elevated to the level of the teeth. Foul saliva dribbled from the mouth. There were several carious teeth in the right lower jaw, X-rays of which showed gross root infection. Temperature 104° F., pulse 120, respirations 30, white blood-cells, 6800.

*Operation.*—Under gas-oxygen anæsthesia a short incision was made under the angle of the jaw and also under the chin. Foul pus escaped from both areas. The organism was not cultured.

*Progress.*—The patient rapidly became worse; his pulse rose to 160–170, cyanosis came in waves and death occurred seven hours after admission. He did not apparently die of asphyxia although he continued to have difficulty in respiration.

Necropsy showed extensive brawny œdema of the neck, mouth and face. There was considerable greenish, foul pus beneath the mylohyoid muscle and in the cellular tissues of the floor of the mouth. Œdema of the larynx was present though not sufficient to cause total obstruction of the air passage. The organs of the chest and abdomen were essentially normal.

*Comment.*—In this instance as in many others that come to a fatal issue, the cause of death is not entirely clear. Toxæmia from the very sepsis undoubtedly plays a part; asphyxia may contribute a part. It is felt that even in cases as advanced as this, there is nothing to contra-indicate the most radical type of incisions, although, in this particular instance it probably would not have influenced the outcome. Several areas of undrained pus were encountered at autopsy.

CASE IV.—Hospital No. 32,075.—*Primary Ludwig's Angina secondary to dental sepsis. Operation. Spontaneous opening in the mouth. Recovery.*

A. B., an eight-year-old girl, was admitted to the hospital complaining of a painful tender swelling of the right side of the neck and face.

Four days prior to admission she had severe pain about a carious right lower molar tooth. The swelling in the neck began shortly afterward and progressed rapidly until

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it involved the side of the face and neck. The tongue became elevated and swollen about twenty-four hours before admission, making swallowing difficult and limited opening of the jaws.

On physical examination the child appeared to be in much pain and acutely ill. An extensive, red, œdematous, brawny, tender swelling of the tissues beneath the right mandible and about the face and neck made opening the jaws difficult. The tongue was swollen and elevated so that the floor of the mouth was level with the teeth. Temperature 101° F., pulse 120, respirations 24.

X-ray examination of the right lower jaw showed an abscess about the second molar tooth.

At operation a transverse incision was made beneath the ramus of the jaw, dividing the mylohyoid. No free pus was found at that time.

*Progress.*—The patient improved almost immediately following operation. On the third day post-operative, an opening in the floor of the mouth established itself and drained a moderate amount of foul pus for several days. The patient was discharged on the ninth day.

*Comment.*—It is impossible to say whether there might have been a small undiscovered pocket of pus present in the sublingual tissues at the time of operation. The interesting fact to be learned is that with ample incision and decompression of the cervical tissues favorable progress was made and the opening of the abscess into the mouth three days after operation had little to do with the alternate course.

CASE V.—Hospital No. 30,032.—*A typical case of Primary Ludwig's Angina of moderate severity possibly secondary to dental sepsis. Operation. Recovery.*

L. W., a woman aged twenty-four years, entered the hospital complaining of pain and swelling beneath the left jaw.

Six days prior to admission there appeared without known cause a slight redness and swelling beneath the middle of the left jaw. This steadily increased in size until the time of admission. At this time she also complained of difficulty in swallowing and inability to close the teeth completely.

Physical examination was typical of a primary Ludwig's Angina. Beneath the left jaw there was œdematous, brawny, non-fluctuating swelling, which was tender on palpation. The teeth were "poor". Swelling in the floor of the mouth made it difficult to close the teeth. There was slight difficulty in swallowing. Temperature 103.2° F., pulse 100, respiration 20, white blood-cells 19,000. The patient appeared acutely ill.

*Operation.*—Under novocain anæsthesia a transverse incision was made beneath the mandible. The mylohyoid was divided, exposing the deep portion of the submaxillary gland and the tissues beneath the floor of the mouth. A small pocket of pus with a pronounced sublingual œdema was found under the mylohyoid. Streptococci were recovered from a culture of the wound.

Progress was relatively uneventful except for a Vincent's Angina infection of the floor of the mouth which cleared up rapidly under local treatment. The patient was discharged from the hospital ten days after admission.

CASE VI.—Hospital No. 29,115.—*Primary bilateral Ludwig's Angina. Operation. Fatality.*

M. S., a woman twenty-three years of age, entered the hospital complaining of an acute attack of dyspnoea with difficulty in deglutition and articulation. Some six days previously she had complained of pain in the throat, had difficulty in swallowing and complained of general malaise. This progressed rapidly and in a few days swallowing became practically impossible. Shortly after onset a swelling appeared in both submaxillary regions, particularly on the left and progressed to the date of admission. On this day she had an alarming attack of acute dyspnoea.

Physical examination revealed an extensive brawny induration about both submaxillary gland areas, an elevation of the posterior part of the tongue somewhat more on the right than on the left side, and a questionable mass in the posterior part of the tongue. Temperature 103.5° F., pulse 150.

*Operation.*—Under gas-oxygen anæsthesia an incision was made through the mucous membrane of the mouth into the base of the tongue on the right side without striking pus. The left submaxillary region was then incised through the mylohyoid muscle and a large quantity of thick foul pus evacuated.

A culture of the wound failed to demonstrate any organism—a doubtful finding.

The patient never regained consciousness, had slight convulsions, became cyanotic and dyspnoic. Death occurred in a few hours.

A necropsy was not obtained.

CASE VIII.—Hospital No. 21,272.—*A typical bilateral, fairly severe, Primary Ludwig's Angina secondary to peritonsillar abscess and tonsillitis. Operation. Recovery.*

L. S., a woman aged twenty-three years, was admitted complaining of swelling in the submaxillary and submental regions. One week prior to admission she had tonsillitis and a peritonsillar abscess which subsided after four days. Twenty-four hours before admission she noticed a swelling in the infra-mandibular regions and submental regions. This was followed by an elevation of the tongue sufficient to make swallowing very difficult. Opening of the jaws was limited and very painful.

Physical examination showed a hard, brawny, œdematous, tender swelling in the submental region spreading back on both sides around the submaxillary gland. The floor of the mouth was œdematous, swollen, and raised to the level of the teeth. Temperature 102° F., pulse 100.

*Operation.*—Under ether anæsthesia an incision was made through the geniohyoid and the anterior part of both mylohyoid muscles. A small pocket of pus beneath the middle of the tongue was evacuated. A culture of the wound demonstrated streptococci and Gram-positive bacilli.

Progress was very satisfactory. There was a temporary increase in the swelling in the floor of the mouth following the operation, which subsided rapidly, and the patient was discharged on the tenth day.

CASE VIII.—Hospital No. 17,505.—*Typical Primary Ludwig's Angina following streptococcus sore throat; involvement of lymph-nodes definite. Operation. Recovery.*

L. B., a woman aged forty years, was admitted complaining of pain in the tongue and beneath the right jaw, difficulty in deglutition, and articulation. These symptoms had been acute for two days.

This illness followed a severe streptococcus infection of the throat which began shortly after an operation two weeks previously (dilatation and curettage) for dysmenorrhœa. The infection lasted five to six days and was so severe that deglutition and articulation were well nigh impossible. Following recovery from this she felt well except for moderate tenderness over the lymph-nodes in the right submaxillary region. Twelve days after onset or two days prior to admission this tenderness increased, the right side of the tongue began to swell and deglutition again became difficult. In twenty-four hours' time the sublingual swelling had increased to such an extent that the jaws could only be moved slightly.

The physical examination centred about the local condition. There was a slight swelling in the right side of the neck below the ramus of the right jaw, extending down to the level of the larynx. A few slightly enlarged lymph-glands in the submaxillary regions could be palpated, although the whole region of the neck was extremely tender. Swelling of the floor of the mouth had proceeded to such a degree that the mouth could be opened only with great difficulty. The tongue itself was swollen, especially in the right posterior third. Temperature 104° F., pulse 96, respirations 24.

Operation under novocain anæsthesia was performed at once. The right mylohyoid

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muscle was divided and a small quantity of pus was evacuated from beneath the tongue. The organism grown was a streptococcus—type undetermined.

Progress following operation was uneventful. The difficulty in deglutition and articulation rapidly disappeared, fever subsided, and the wound granulated in well. The patient was discharged eighteen days after admission.

*Secondary Ludwig's Angina.*—Turning now to that group of cases of sublingual phlegmon which we have set apart under the title of Secondary Ludwig's Angina, we may consider the reasons for doing so.

First, the immediate source of focus of infection from which the sublingual tissues become involved is not in the cellular tissue around the lymph-nodes. That most usually encountered, as illustrated by Cases IX and X, is an infection or an abscess of the lymph-nodes themselves in the mental, submental, or anterior submaxillary regions in contradistinction to an infection of the cellular tissue around the lymph-nodes or in submaxillary glands as in the primary anginas. A pure cellulitis in these regions may likewise serve as a point from which re-infection may occur though this seems to be less common than abscess or lymphadenitis.

Second, the outstanding difference between primary and secondary Ludwig's Angina is the manner in which infection spreads to the floor of the mouth. The path of the secondary type is a direct one through the muscles or their median raphé instead of through the loose areolar tissue about the posterior edge of the mylohyoid muscle where a lappet of the submaxillary gland curls about it, as in the primary type of the disease. As will be seen in reports of Cases XI, XII and XIII, the area of cervical involvement is well anterior to the submaxillary gland until very late in the disease. In fact, the sublingual phlegmon antedates the spread to the tissues about this gland. Where abscesses are found to be actually burrowing through the muscles there can be no doubt as to the mode of extension.

This different mode of extension, when we consider that the muscles of the floor of the mouth constitute a much greater barrier to perforation and extension inward than does the loose cellular tissue about the submaxillary gland, readily explains why clinically the sublingual phlegmon of secondary Ludwig's Angina appears considerably later than in the primary type.

Third, the sublingual phlegmon in secondary Ludwig's Angina has in the majority of cases quite different characteristics from the infection due to the lymphadenitis or abscess from which it usually arises. It represents, as a rule, the same type of a cellulitis found about an infected lymph-node or the periphery of an abscess in any locality. Until rather late one does not find actual pus in the sublingual tissues and then it usually represents a direct burrowing through of the original abscess. Frank pus was found in the sublingual tissues in seven out of eight instances in the primary cases, compared to two out of eight in the secondary type. Leterrier's experience is similar to ours, *i.e.*, it is necessary in true Ludwig's Angina to get beneath the mylohyoid muscle before pus is encountered. This is probably to be explained by the greater virulence of the infection in the first group of cases and to ischæmic tissue necrosis in a confined space.

It may be added that in our experience in secondary as in the primary type, the sublingual phlegmon never appears prior to the cervical infection even in such instances as compound fracture of the jaw with laceration of the oral mucous membrane or osteomyelitis of the jaw.

CASE IX.—Hospital No. 40,092.—*Secondary Ludwig's Angina. Extraction of teeth in presence of dental sepsis followed by submental cellulitis and later sublingual cellulitis. Operation. Recovery.*

C. A. W., a male fifty-six years of age, entered the hospital complaining of swelling beneath the chin and right mandible, and slight swelling of the floor of the mouth. For some three weeks prior to admission he had an exacerbation of infection in the teeth of the right lower jaw. About two weeks before, several teeth of the right lower jaw were extracted. Following this a swelling appeared in the submental and right submaxillary regions which progressed slowly to the date of admission. About twenty-four hours before admission the floor of the mouth began to be elevated.

On physical examination there was a tender hard swelling in the submental and anterior submaxillary regions. The floor of the mouth was moderately elevated anteriorly. Pus could be pressed from root sockets where teeth had been removed.

At operation which was performed under local anæsthesia, frank pus was encountered beneath the deep fascia in the submental and anterior submaxillary regions. The mylohyoid muscle was punctured with a hæmostat but not divided. No frank pus was encountered beneath this muscle. Convalescence was uneventful and he was discharged on the fourth day post-operative.

*Comment.*—This case affords a clear example of sublingual cellulitis following a submental and anterior submaxillary region abscess. There never was any evidence of extension directly from the mandible to the sublingual tissues. The submaxillary gland region was not involved. Infection no doubt spread through the muscles of the floor of the mouth.

CASE X.—Hospital No. 39,404.—*Extraction of teeth followed by submental and submaxillary region induration. Secondary abscess formation and involvement of sublingual tissues through the mylohyoid muscle. Operation. Recovery.*

G. M. R., a woman aged thirty years, was admitted complaining of a swelling beneath the chin and the right lower jaw.

Some six weeks prior to admission she had undergone an unsuccessful attempt to have a painful wisdom tooth extracted. At this time the second molar tooth was broken in the attempt. Both were removed a month later. Four days before admission a swelling appeared beneath the right jaw. This gradually increased in size over a period of five or six days before a swelling of the floor of the mouth on the affected side was noted. Operative interference was advised at once.

*Physical Examination.*—The patient appeared ill. The skin was hot and dry, the face flushed. Temperature 101° F., pulse 120, respirations 20. Beneath the chin and extending over toward the angle of the right jaw was a moderate swelling, tense and painful but not red or fluctuating. The right side of the floor of the mouth was elevated moderately.

*Operation.*—Under local anæsthesia an incision parallel to the ramus of the jaw was made dividing the mylohyoid muscle. Two small separate abscesses were found involving the mylohyoid muscle, one in the submental region and one anterior to the submaxillary gland. The pus was thin and foul. No frank pus was found in the sublingual region. A culture of the wound was sterile.

Progress was uneventful and the patient was discharged six days later.

CASE XI.—Hospital No. 31,723 R.—*Secondary Ludwig's Angina. Compound fracture of mandible in right incisor region followed by infection of submental and*

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*anterior submaxillary region; secondary direct extension to the floor of the mouth.*  
*Operation. Recovery.*

C. L. S., a male aged thirty, entered the hospital with a compound fracture of the mandible near the right incisor region and a severe laceration of the soft tissues about the external site of fracture. Two days later swelling developed principally about the submental region and extended to the anterior submaxillary area. This increased steadily until April 1, four days after entry. Within a few hours it rapidly extended to the sublingual tissues, raising the tongue nearly to the roof of the mouth; swallowing became difficult and respirations were slightly impaired. Temperature 102° F., pulse 90, respirations 20, white blood-cells 10,400.

Operation performed at once under local anæsthesia consisted of a transverse incision dividing the anterior two-thirds of the mylohyoid muscle which connected with vertical incisions extending from the mandible to the hyoid bone. A small pocket of thin, watery pus was found beneath the deep cervical fascia. Culture showed the organism to be staphylococcus albus. No frank pus was found in the indurated sublingual tissues. Convalescence was rapid and smooth.

*Comment.*—This case illustrates the tendency for infection in the neck to penetrate the muscles composing the floor of the mouth. Infection from the site of the fracture had extended by the lymphatics to the submental and submaxillary lymph-nodes. It was not until this was well established that the sublingual tissues were involved. There was no evidence whatever that the sublingual infection proceeded by contiguity directly from the fractured mandible to the floor of the mouth. As a matter of fact there never was any appreciable degree of infection about the site of fracture.

CASE XII.—Hospital No. 39,028.—*Secondary Ludwig's Angina secondary to abscess in submandibular region involving the floor of the mouth. Drainage of abscess followed by sublingual phlegmon. Re-operation with tracheotomy. Recovery.*

S. B., an Italian shoemaker aged twenty-eight years, entered complaining of a swelling beneath the left mandible. Seven or eight days prior to admission he noticed a small lump beneath the left mandible which was moderately painful and remained about the same size for five days. It then rapidly became larger and much more painful. For the two days before admission he experienced fairly severe pain, especially when opening the jaws and slight difficulty in swallowing. There was no difficulty in breathing.

The past history is irrelevant except for a penile chancre ten years ago followed by secondary skin lesions. He gave a history of decayed teeth for "years" but had not given them any attention.

On physical examination there was a red, tender, tense, swollen area 6-8 cm. wide beneath the left mandible. Fluctuation could not be made out. Dental sepsis and pyorrhœa about the lower incisors and canine teeth was fairly marked. There was no evidence of swelling in the floor of the mouth. Breathing and swallowing were unimpaired. Temperature 103° F., pulse 100, respiration 20, white blood-cells 11,800.

*First Operation.*—Under ethylene anæsthesia an incision 8 cm. was made over the swelling. About 50-60 c.c. of thick pus was evacuated from a pocket about the submaxillary gland. It had as a part of its wall the mylohyoid muscle. The posterior portion of the mylohyoid muscle was divided, inasmuch as the cavity seemed to extend forward toward the anterior end of the floor of the mouth outside of that muscle. Two rubber drainage tubes were inserted and the patient returned to the ward in good condition. A prompt regression of symptoms following the evacuation of pus was expected. The organism recovered from the wound was staphylococcus albus.

*Progress Note.*—The next morning, the patient presented an alarming picture. The floor of the mouth was flush with the teeth and the tongue elevated to the roof of the mouth. Temperature 104.2° F., pulse 110, white blood-cells 11,000. Blood culture taken

eighteen hours after the first operation failed to grow any organism. Swallowing and respiration were difficult, especially when lying down. Slight improvement followed the removal of drainage tubes and packing, and the patient was watched carefully for a few hours. Symptoms did not materially improve and twenty-four hours after the first operation a further incision was made.

*Second Operation.*—Under local anaesthesia an attempt was made to extend the division of the mylohyoid muscle to its anterior extremity. No pus was encountered. Lack of coöperation of the patient necessitated giving a small amount of ether, before a pocket of pus at the anterior end of the floor of the mouth could be evacuated. The sudden cessation of respiration necessitated a rapid tracheotomy and artificial respiration. Breathing was promptly resumed. The organism that was recovered at this time was a pneumococcus.

*Progress.*—A catheter attached to a suction apparatus was inserted through the tracheotomy tube at once and continuous aspiration maintained until the swelling of the floor of the mouth had subsided sufficiently to enable him to expectorate, a period of about five days. The amount aspirated varied from 200 to 700 c.c. per day. Examination of the chest during this period showed numerous râles at both bases with dulness and increased tactile fremitus. A flat X-ray plate revealed increased density in both lower lung fields. Temperature, pulse and respiration gradually returned to normal and he was discharged with a wound nearly healed, nineteen days after admission.

*Comment.*—This is a clear instance of sublingual phlegmon which arose from a localized submandibular abscess in which the mylohyoid muscle made up a part of the abscess wall. The factor which incited this quiescent abscess into a rapidly spreading phlegmon is a question though the trauma of operation doubtlessly contributed something to it. The use of the suction to aspirate the trachea was of utmost importance, especially when expectoration was impossible. It may have presented an even more grave bronchopneumonia than did occur.

CASE XIII.—Hospital No. 39,936.—*Abscess of neck secondary to dental sepsis. Definite lymph-node involvement. Part of abscess wall made up by posterior edge of mylohyoid muscle. Sublingual phlegmon part of abscess wall swelling. Operation. Recovery.*

L. C. F., a man aged twenty-seven years, was admitted complaining of a swelling beneath the right lower jaw. Past history irrelevant except for carious teeth for the past two years.

*Present Illness.*—Some eighteen days prior to admission the patient was forced to go home from work because of general malaise and weakness. In a few hours he had a chill lasting from fifteen to twenty minutes. The next morning his throat was very sore from a tonsillitis which lasted four or five days. At the same time that his sore throat began, the second molar tooth on the right lower jaw began to pain him and in a day or so a swelling appeared beneath the jaw. This continued to increase in size, up to the date of admission. The pain and the loss of sleep associated with it finally forced him to come to the hospital. Difficulty in swallowing began about three days previously and progressed until only fluids could be taken. On the day of admission it became a little difficult to twist the tongue about in the mouth.

*Physical Examination.*—The patient was an acutely ill male complaining of considerable pain in the right cervical region. There was a diffuse, red, hard, tender, oedematous swelling about the right lower jaw, extending from the face to below the larynx and from the midline to the angle of the jaw with oedema going around to the back of the neck. The jaws could be opened about one-half the normal distance. The teeth and mouth were dirty and ill cared for. Cavities in the first and third molar teeth were evidently of fairly long standing. The tongue itself appeared normal. The floor of the



mouth on the right side posteriorly was moderately elevated. Temperature 103.3° F., pulse 96, respiration 20, white blood-cells 13,400. X-rays of the jaw failed to demonstrate any root abscesses.

*Operation.*—Under local anæsthesia an incision 8 cm. long was made beneath the ramus of the right jaw. In both the submental and submaxillary regions, enlarged lymph-nodes were encountered. A pocket of pus (about 25–30 c.c.) was encountered near the posterior edge of the mylohyoid muscle. Culture of this showed staphylococcus aureus. The abscess cavity extended beneath the muscle and had destroyed the posterior part of the muscle. The entire muscle was divided, allowing ready access to connective tissues of the floor of the mouth.

Progress was quite uneventful and the patient was discharged on the tenth day. After leaving the hospital a secondary abscess below the line of incision formed and discharged into the wound.

*Comment.*—This case is a very important link in the chain of evidence that cervical abscesses can and do invade the floor of the mouth directly. In this instance a part of the muscle had been destroyed by the abscess wall. The history of the onset is too long for a primary or true Ludwig's Angina. The relatively slight sublingual swelling was out of proportion to the great amount of swelling and œdema in the cervical tissues. The enlarged lymph-nodes encountered at operation are fairly commonly seen in secondary anginas though occasionally encountered in the primary group.

CASE XIV.—Hospital No. 39,438.—*Submental abscess secondary to impetigo on chin. Secondary involvement of sublingual tissues. Operation. Recovery.*

A. M. A., a woman aged twenty-two, was admitted complaining of a swelling in the submental region of three days' duration. Three weeks prior to admission she developed an impetigo sore on the chin which persisted in spite of various forms of treatment. Three days prior to admission there appeared a progressively increasing swelling in the submental region which was considered lymphadenitis. Shortly after admission the swelling had increased to such an extent that the movements of the tongue were a little embarrassed. Some twelve hours after admission she had an acute attack of dyspnoea. The floor of the mouth was now markedly swollen and both submaxillary regions were full, especially the left. Temperature 101.2° F., pulse 110, respiration 20, white blood-cells 10,200.

Operation performed under local anæsthesia consisted of a vertical incision extending from the chin to the hyoid bone, separating the muscles down to the floor of the mouth. A few drops of pus were obtained beneath the deep cervical fascia just to the right of the midline.

*Progress.*—During the next twenty-four hours all of her symptoms became much worse, i.e., difficulty in breathing and swallowing, swelling in the submaxillary region and swelling of the tongue and of the floor of the mouth. Further intervention became imperative.

At a second operation, also under local anæsthesia, incisions were carried laterally from the vertical incision to divide both geniohyoid and mylohyoid muscles. A few drops of pus were obtained beneath the muscles.

*Progress.*—Following this procedure the patient made a very satisfactory convalescence. The œdema in the mouth and neck began to subside in about twenty-four hours. She was discharged on the fourteenth day.

*Comment.*—This case adds another valuable bit of evidence regarding the mode of extension of infection through the mylohyoid muscles. At the first operation the pus was encountered beneath the cervical fascia. At the second it was found beneath the muscles of the floor of the mouth. The

submaxillary gland regions were only involved secondarily by spreading cervical cellulitis. Anatomically there is no evidence whatever that the lymphatic drainage from the mental region where this infection originally started is into the floor of the mouth. Rather, as Sappy points out, the mental region drains into the submental and submaxillary lymph-glands. The path of infection certainly did not lead to the submaxillary salivary gland region and thence to the floor of the mouth as in a true or primary Ludwig's Angina.

CASE XV.—Hospital No. 36,909.—*Dental sepsis with recurrent attacks of submaxillary indurations, the last of which was associated with sublingual phlegmon and abscess formation. Spontaneous inadequate drainage into the oral cavity. Operation. Recovery.*

W. I. H., age fifty-three years, a farmer, entered the hospital on September 20, 1926, complaining of carious teeth and a recurrent swelling beneath the right jaw, also swelling of the floor of the mouth.

Some three months prior to admission the patient had the first of a series of four recurrent "lumps" beneath the right jaw. Each lasted about a week, was associated by moderate dysphagia, fever, malaise and weakness sufficient to confine him to bed. During the third attack an X-ray examination of the teeth of the right lower jaw was made which demonstrated several apical abscesses.

The present attack began about five days ago with fairly painless swelling beneath the right jaw. The swelling increased and at the end of three days it had extended from the chin to the angle of the jaw. Pain became fairly acute. On the fourth day the floor of the mouth began to swell and deglutition and speech became impaired. On the day of admission the pain was severe, the tongue lifted into the roof of the mouth and dysphagia was fairly marked. Saliva dribbled from the mouth. X-ray examination of the jaw again revealed inflammatory reaction about the roots of the molar teeth of the right lower jaw. Temperature 99.2° F., pulse 110, respirations 22, white blood-cells 13,500. The family history and past history are irrelevant except for carious teeth for "years".

*Physical Examination.*—The patient was a large, rugged, somewhat obese adult male with a short fat neck and a double chin. Beneath the right jaw was an extensive swelling extending from the angle of the jaw forward to beyond the midline. There was moderate œdema of the skin but no redness and but little tenderness on pressure. The tongue was dry, brownish, parched, and elevated nearly to the roof of the mouth. The right side of the floor of the mouth was about even with the teeth. Swallowing was moderately difficult.

*First Operation.*—Under novocain anæsthesia, the skin and subcutaneous tissues were divided down to the mylohyoid without striking pus. All the tissues were œdematous and brawny. Gas-oxygen anæsthesia was then given in order to divide the posterior part of the mylohyoid muscle. No pus was found. A loose acriflavin gauze drain was inserted into the wound. The organism recovered from the wound was staphylococcus albus.

The patient's condition did not improve and eighteen hours later a small incision under local anæsthesia was made in the floor of the mouth on the right side, where the swelling was the greatest. No pus was found. A few moments later a small amount of pus was spat up. The source could not be ascertained. Temperature 102° F., pulse 100, respirations 28.

No improvement followed this and twenty-four hours later the neck was re-explored under local and gas-oxygen anæsthesia. The incision was carried backward until the whole submaxillary gland was exposed without finding anything except brawny œdema. The incision was then carried forward and after dividing the mylohyoid and geniohyoid

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muscles, a small pocket of foul pus was encountered in the midline beneath the anterior part of the tongue.

Fairly prompt convalescence followed the drainage of this pocket. The swelling in the tongue and the floor of the mouth receded rapidly. Deglutition and respiration improved promptly.

*Comment.*—It is difficult to see how the sublingual phlegmon arose in this instance unless by direct extension through the floor of the mouth. The submaxillary induration was in all the attacks the usual type of lymph-gland infection deep to the cervical fascia. In the last and most severe attack the process spread by direct contiguity through the floor of the mouth muscles into the sublingual tissues. There seems no need to presume that the submaxillary gland or its capsular tissues were the focus from which infection was relayed to the sublingual tissues. In fact, at operation the submaxillary gland region was not particularly involved. Neither need one presume a retrograde lymphatic infection from the submaxillary gland region to the anterior part of the floor of the mouth where the infection was most severe and the abscess found.

CASE XVI.—Hospital No. 16,569.—*Abscess of submaxillary region beneath deep fascia with secondary involvement of cellular tissues of the floor of the mouth. Operation. Recovery.*

F. W., a woman twenty-three years of age, was admitted to the hospital complaining of difficulty in swallowing and swelling of the right side of the neck.

Five days previously she had a carious tooth extracted from the right lower jaw. Two days after this a swelling appeared about the right lower jaw and with its continued increase in size, difficulty and pain on swallowing became fairly marked.

On physical examination there was found a hard, regular smooth swelling beneath the right lower jaw extending over to the midline. The floor of the mouth was moderately swollen. The first and third right molar teeth were missing. Temperature 99.6° F., pulse 110, white blood-cells 23,000.

Operation consisted of an incision through the deep cervical fascia on the right side. Free pus was found and the pocket drained; the mylohyoid muscle was not divided. A culture of the wound showed the organism to be a streptococcus.

Progress was uneventful. The patient was discharged on the ninth day with the swelling nearly gone.

*Comment.*—This would seem to be an undoubted instance of sublingual phlegmon secondary to a pocket of frank pus beneath the deep cervical fascia. The record unfortunately does not indicate whether the mylohyoid muscle was part of the abscess wall or not. No mention made of involvement of the submaxillary gland. In neither of the two preceding cases was the process in the sublingual tissues of the same character as that in the neck. This differs from primary Ludwig's Angina when the two are usually identical. In this case the sublingual process was a pure phlegmon with a cervical abscess while the reverse was true in the preceding case.

*Etiology.*—Newcombe,<sup>7</sup> commenting on true Ludwig's Angina, says that "the true way to look upon the disease is to regard it first as an intensely infectious phlegmon, and second, as occurring under peculiar anatomical conditions." This is even more true of sublingual phlegmon alone. Streptococci are commonly the infecting organism in the primary type of the disease

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and staphylococci predominate in the secondary type. While bacteriological studies have been routinely made, they have not been sufficiently detailed in our cases to warrant any new conclusions. A sterile culture from a wound in such an infection is to be looked upon with suspicion. Smears of the fluid or pus stained by Fontana's method would probably show spirochaetes to be the infecting organism. Ordinary bacteriological studies fail to grow these organisms.

Predisposing causes and original sources of infection are the same in the two groups of cases. Hamann,<sup>8</sup> in 1894, called attention to the major rôle that dental sepsis plays in such infections. Compound fractures of the lower jaw, impetigo of the face, wounds of the floor of the mouth, tonsillitis, scarlatina and diphtheritic infections all have been mentioned in a few instances as the etiologial factor. The early impressions that sublingual phlegmon was a disease "sui generis" probably arose from an occasional observation of this type of infection in healthy robust individuals in whom none of these predisposing causes could be demonstrated.

The age incidence is practically the same in both groups of cases and is greatest between the years of twenty and thirty. The youngest patient was eight and the oldest fifty-six. In our series the incidence is greater in females. In the primary anginas there were seven females and one male. In the secondary anginas three females and five males. This ratio is quite the reverse of that given in the literature for true Ludwig's Angina where males predominate.

*Clinical Course.*—Primary Ludwig's Angina begins and continues to its termination as a fulminating rapidly spreading cellulitis. This is quickly be that of pain from carious teeth or a transitory tonsillitis. The onset may be obscured by the pain in the submaxillary gland region due to distention of tissues. Tension on the cervical tissues is usually great enough by the third day or fourth to force an extension to the sublingual spaces. Here the process of sublingual phlegmon may continue for three to four more days before definitely invading the larynx in the manner to be described. The time in which a typical untreated case may come to a fatal issue is from nine to twelve days. The actual symptoms of involvement of the sublingual and laryngeal tissues are too well known to redescribe except to point out the very great suddenness with which laryngeal obstruction may come on. That death may supervene in a few moments in subjects who have apparently no respiratory distress has been attested by a number of writers.

As one might surmise from the pathological anatomy of secondary Ludwig's Angina, the symptoms are naturally less fulminating. It is common to obtain a history of cervical, submental or intra-oral sepsis for a week or ten days before there are any sublingual symptoms. In Case XIV there had been recurrent attacks of cervical lymphadenitis for months before the final attack. Symptoms are less severe. Laryngeal involvement is a much later manifestation than in the primary type of the disease and occurs much less frequently. The mode of invasion of the larynx is nevertheless the same.

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*Invasion of the Larynx.*—Obstructive laryngeal symptoms are a fairly late manifestation of the disease and naturally vary with the rapidity with which the infection spreads. It is no doubt true that with wider recognition of the nature of the malady fewer cases go on to a critical stage of respiratory embarrassment than in Ludwig's time or even twenty years ago when Thomas' excellent study of this condition was published.

The path by which infection spreads from this space into the larynx is, as Thomas suggested, a postero-lateral one. There is a hiatus between the posterior edge of the mylohyoid muscle and the middle constrictor muscle of the pharynx filled with loose areolar tissue. In the lower part of this space are to be found the tendon of the stylohyoid muscle and the glossopharyngeal nerve. Both course along the side of the larynx and may easily serve as a ready guide to a spreading cellulitis.

In an attempt to determine if this pathway for infection could be demonstrated experimentally, we injected under force a thick watery barium suspension into the sublingual tissues in four fresh autopsy specimens. In each of these the barium could be traced into two locations—first, about the sublingual salivary gland and out into the tissues of the submaxillary region, and secondly, and quite distinctly, into the tissues at the side of the epiglottis and larynx. The amount naturally was small but nevertheless unmistakable. Likewise the path by which it reached the larynx was in accord with that mentioned above, *i.e.*, through the space between the middle constrictor muscle and the mylohyoid muscle.

*Treatment.*—Early radical surgical intervention cannot be too strongly urged. The fundamental principal of operation for sublingual phlegmon and consequently for both types of the disease is primarily to relieve tension and secondarily to relieve pus. For this reason short incisions have little if any place. When the sublingual tissues have become tense and indurated, as Leterrier<sup>12</sup> and Niedermeyer<sup>13, 14</sup> in particular have pointed out, an incision should be made to divide the mylohyoid and possibly the geniohyoid muscle on the affected side. By beginning in the region of the submaxillary gland and keeping close to the ramus of the mandible as the incision is carried forward, no structures of importance are encountered except the facial artery. A word of caution may not be amiss in regard to dividing this. It is apt to be stretched outward like a bow string by the underlying swelling, and if divided before being secured may retract well into the cedematous tissue, giving troublesome bleeding.

Where the principal part of the cervical infection is submental or anterior to the submaxillary region a T-shaped incision is very useful, the shorter limb of the incision being from the mandible to the hyoid bone. As mentioned above, short incisions one to two inches long are theoretically unsound and usually prove inadequate and temporizing. Intra-oral incisions fail to give the decompression for the tension in the sublingual tissues and are impossible to keep clean and aseptic. Such incisions, made for cosmetic reasons only, as suggested by Jacques,<sup>15</sup> have no place in so serious a malady. Spon-

taneous opening of a small abscess in the floor of the mouth in either primary or secondary Ludwig's Angina rarely affords sufficient drainage or relief of the tension on the tissues and an adequate external incision should be made without delay even in the presence of spontaneous intra-oral drainage. Removal of the submaxillary gland suggested by Rehn<sup>16</sup> is unnecessary if the mylohyoid muscle is adequately divided and the capsule of the gland incised when this is necessary. It has been our own plan to go as far as possible with local anæsthesia—blocking off the cervical nerves posterior to the sterno-mastoid muscle—and if necessary to administer a short nitrous oxide oxygen anæsthesia to complete the incision.

A tracheotomy set should be a part of the armamentarium in any case where there has been any laryngeal symptoms at all. As mentioned under the comment on Case XIII, suction of the tracheal secretions through a small catheter in the tracheotomy tube may be a life-saving measure. It should be practically continuous until subsidence of the swelling beneath the tongue will again permit expectoration.

*Mortality.*—The mortality is reduced in proportion to the promptness and thoroughness with which the sublingual tissues are "decompressed" and relieved of tension and any pockets of pus evacuated. Among 106 collected by Thomas up to 1908 the mortality was 40 per cent. We have collected 92 cases appearing in the literature since that date which seemed to be authentic. The mortality in this group was 31 per cent. Among our own cases there was a mortality of 25 per cent. (two out of eight cases) among the primary Ludwig's Angina with no fatalities among the secondary type which makes a combined mortality of 12½ per cent. The difference in the two groups doubtlessly represents the relative frequency with which the larynx is involved. The cause of death is not certain in all instances. Toxicity from the marked sepsis undoubtedly has a great deal to do with it. Partial asphyxia may also contribute. Only occasionally does a sudden total occlusion of the larynx by œdema of the glottis cause death.

#### SUMMARY AND CONCLUSIONS

1. Sublingual phlegmon is a malady of major surgical importance which is found as the dominating symptom of primary or classical Ludwig's Angina. It is also seen as the outstanding feature of another group of infections about the neck which in the literature and the clinic have been erroneously coupled with primary Ludwig's Angina on the strength of this one symptom.

2. The confusion this has created has led us to set these latter cases apart under the name of secondary Ludwig's Angina.

3. Secondary Ludwig's Angina differs from the primary or classical type of this disease, in that (a) the sublingual phlegmon is secondary to lymph-gland infection and cervical abscess rather than to an infection of the cellular tissues about the lymph-glands or submaxillary salivary gland; (b) the sublingual tissues are infected by a direct extension through the muscles which make up the floor of the mouth. Extension is through the

"On opening the peritoneal cavity it is found to be filled with about 1500 c.c. of fluid purulent material. The coils of the intestine are sealed together by a thick layer of yellow fibrous material. In the region of the incision in the right upper quadrant there are dense fibrous adhesions. The liver is firmly adherent to the diaphragm by fibrous adhesions. The diaphragm arches to the sixth rib on the left; its place on the right is not determined. Examination of the peritoneal cavity in the region of the incision on the left side shows a sinus opening between the external surface of the abdominal wall and the jejunum near its beginning. The opening is firmly sutured and there is no evidence of leakage. Examination of the biliary tract shows a catheter to have been inserted with its bell end in the hepatic duct. Its opposite end was in the duodenum. The hepatic duct is quite markedly dilated and contains a thick inspissated bile. There is a partial repair of the biliary tract so that the catheter is covered save for a distance of about 3 cm. in length.

The entire dome of the liver is adherent to the diaphragm by dense adhesions. On section the liver tissue is pale and swollen and the markings are indistinct. There is apparently a slight increase in consistence of the organ and the centres of the lobules show slight bile staining. The gall-bladder wall is somewhat thickened and its surface covered with dense fibrous adhesions. When opened there is a small amount of mucoid bile in its cavity. There is no evidence of stones in the gall-bladder or the biliary tract. The head of the pancreas is firm and nodular and dissection of the common duct as it passes through the head of the pancreas shows the lumen of the duct to be completely obliterated. The gall-bladder is buried in a bed of fibrous adhesions and the cystic duct is also practically obliterated. The anastomosis stoma is considerably narrowed.

On section the head of the pancreas is found to be made up of a gray granular friable tissue. This tissue is well localized in the head of the organ and fairly well defined. There is no evidence of infiltration save in one small regional lymph-node. The gastro-intestinal tract is negative save for the duodenum which shows a rent on the anterior surface, measuring 2 cm. in diameter. It has been sutured but the suture line has broken down and there is leakage of intestinal content which probably is responsible for the peritonitis.

Microscopically, the lesion in the head of the pancreas is adeno-carcinoma. The common and cystic bile-ducts are invaded by carcinoma.

*Diagnoses.*—1. Carcinoma of head of pancreas. 2. Diffuse peritonitis. 3. Duodenal fistula. 4. Jejunosomy. 5. Cloudy swelling of heart, liver and kidneys. 6. Operative repair of biliary system (attempted). 7. Obstruction of common (complete) and cystic bile (partial) ducts by carcinomatous infiltration.

*Discussion.*—When anastomoses between the gall-bladder and the stomach or duodenum are made in the experimental animal infection of the bile-passages usually obtains. Radsiewsky<sup>22</sup> did five cholecystojejunostomies in dogs. A few months later when the dogs were killed bacteria were found in both the extra- and intrahepatic bile-ducts. Radsiewsky described the process as a desquamative catarrhal inflammation. There was no evidence of suppuration.

Hubicki and Szerzynski,<sup>11</sup> according to Kehr, made anastomoses between the gall-bladder and the upper intestine in seven dogs. About a year later when the animals were killed very definite evidence of infection was found in four of the animals. Mocquot<sup>24</sup> did similar anastomoses in five dogs and killed the animals from five months to a year later. Infection was found in the extrahepatic bile-ducts in all. The liver itself escaped infection. Gatewood

loose areolar tissue about the submaxillary gland as it curls about the posterior border of the mylohyoid muscle; and (c) the sublingual phlegmon is to be looked upon as the peripheral manifestation of a cervical abscess or lymph-gland infection and not as an integral part of an original fulminating cellulitis as in primary Ludwig's Angina.

4. The formation of pus in the sublingual tissues is the rule in primary Ludwig's Angina and rare in the secondary type of the disease. Streptococci predominate in the former group and staphylococci in the latter.

5. Extension to the larynx occurs much more frequently in primary Ludwig's Angina. The phlegmon finds its way to the side of the larynx and epiglottitis by extending through the aperture between the posterior edge of the mylohyoid muscle and the middle constrictor of the pharynx.

6. The theory on which the successful treatment of both types of the disease is based is primarily to relieve tension or to "decompress" the sublingual tissues and secondarily to evacuate pus which may extend well into the muscles of the tongue.

7. The mortality of the disease in 104 cases collected by Thomas in 1908 was 40 per cent. In primary Ludwig's Angina there have been no fatalities. In secondary Ludwig's Angina there have been 25 per cent.

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# ULCERATIVE COLITIS \*

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ULCERATIVE colitis was first described as a pathological lesion by Wilks and Moxon in Lectures on Pathological Anatomy in 1875. Thirteen years later, or in 1888, appeared apparently the first clinical description by Sir William Hale White. From this time on little was written on the disease for many years. While separation into amebic and bacillary types was definite, there remained a large number of cases of the so-called non-specific type, which were the cause of much worry and apparently fruitless study. In 1909, in a symposium on the non-specific type held by the Royal Society of Medicine in London, the cases were reported by the various hospitals; St. George's, 19 patients, 9 died, 10 relieved; 4 operations, 3 improved, 1 died; St. Mary's, 19 patients, 15 per cent. mortality; St. Thomas', 80 patients, 40 died, 15 operations, 8 late of whom all died, 7 earlier, 1 died; Westminster, 42 patients, 19 died. In a discussion of the disease before the same society in 1923, Sir Humphrey Rolleston summarized the situation admirably in a statement that ulcerative colitis was not a disease in the strict sense of the word any more than rhinitis or bronchitis but was a syndrome with fairly constant clinical manifestations and anatomic changes which may be excited by different factors with the probability that the ulcerative process originally due to one microorganism may be kept up by the combined attack of different bacteria or to successive strains of pyogenic bacteria. Mr. P. Lockhart-Munro in a similar discussion noted the commonly fatal consequences of the disease and the small advances that had been made in the diagnosis and treatment in recent years. This latter statement was based more particularly on the failure of elucidation from the point of view of bacteriological investigation and likewise the failure of medical treatment to give relief except in the mild cases. In 1924, however, there appeared in the Collected Papers of the Mayo Clinic the work of J. Arnold Bargen. In this he submits for the first time the finding in repeated cases of ulcerative colitis of a Gram-positive diplococcus "plump, with a tendency to be lancet-shaped—about the size of pneumococci—no capsules, little tendency to grow in chains, and on blood agar plates forming colonies resembling the alpha-hemolytic streptococcus." With pure broth cultures of some strains of those streptococcal types recovered from the ulcers of chronic colitis cases, intravenous injections into rabbits and dogs have produced, in a high percentage of cases, lesions essentially like those in human beings. Moreover the diplococcus has been reisolated from the heart's blood and mesenteric lymph-nodes of animals dying from the disease and these cultures have produced similar

lesions when reinjected into other animals. While this experimental work is not final in the determination of the cause of this disease, it is a most important step toward establishing a specific cause for a large number of cases. Prior to this, the etiologic factors were numerous and uncertain, each had its advocates among men of experience in handling the disease. Logan and his co-workers assumed metabolic disturbance to be the underlying cause, many workers considered the amœbæ or dysentery bacilli to be the original invaders and the ulcerative colitis to be due to secondary infection. The German workers and Bassler considered increased virulence of the colon bacillus to be of paramount importance. Rolleston, Lockhart-Mummery, Brown and Yeomans emphasized the importance of the streptococci. The uncertainty of etiology as shown above has been well reflected in the terminology of the disease ulcerative colitis—non-specific, infectious, post bacillary, septic, idiopathic.

During the past year we received on the Cornell Surgical Division at Bellevue Hospital four cases of this disease which proved to be of such surgical interest that they led me to review the seventeen cases we have had on the Surgical Service and the sixty-four diagnosed similarly on the combined Medical and Surgical Service. This review was made, naturally, with the idea of ascertaining what surgical treatment was best indicated in these cases and when such intervention should be made, and like every such review brought to my attention certain facts and findings that I hope may prove of interest to this society.

Ulcerative colitis is an inflammatory disease of the colon, probably infectious, characterized by an extremely varied clinical and pathological course, from the mildest grade of inflammation of the mucosa to the most profound type of phlegmonous infiltration which may end speedily in peritonitis or perforation and death. Fortunately it usually assumes the milder forms, probably due to the specific bacterial factor, and tends toward chronicity or at times toward remissions. Such remissions may be of long duration only to be interrupted by a sharp exacerbation which may in turn equal or surpass the previous attack in severity and which strongly suggests in these cases a consideration of the colon as a sensitized area of infection, reawakened by either a "bacterial shower" from some distant focus, or lighting up in a patient of lowered resistance. In incidence, men are more prone to show the disease than women and in men the years between twenty and forty show more cases than the decades above or below, although no age seems completely immune. Foci of infection such as teeth, tonsils, respiratory tract, gall-bladder, etc., are given as significant findings in a strikingly large number of the cases, either by the history of onset or as physical findings with the disease itself.

Bacteriologically little has been done specifically on the disease until the work of Barger. This work is illuminating and stimulating. In our last three cases we were fortunate enough to have the cooperation of Doctors Torrey and Kahn of the Cornell Department of Hygiene in working on the

bacteriology. One case looked like a Barger's diplococcus, one showed a streptococcus growing best under anaërobic conditions, one was reported non-committally. These were after repeated cultures from the bases of ulcers, specially cultured, virulence tested as to the colon bacilli and conservatively reported. Oddly enough the third case is the only case in our series apparently helped by emetin although no amœbæ were ever found. Other cases have been searched for amœbæ and acid fast bacilli and emetin tested without result. Interesting in this connection is the observation of Lockhart-Mummary that some of the worst cases are secondary to amœbic or bacillary dysentery and the report of a striking result in one case of Crohn's by two injections of polyvalent antidyenteric serum, but whether the result was due to the serum therapy or the protein shock therapy is left open to individual opinion.

Symptomatically the disease presents a fairly familiar picture characterized by diarrhoea of varying intensity from four to even twenty or more stools a day, frequently accompanied by tenesmus or mild colicky pains depending on the severity of the lesions in the rectum or in the colon above the rectum. The stools contain blood or pus in varying amounts. Fever usually accompanies the condition and varies from a nightly rise of one or two degrees to the almost typhoidal type of temperature in the severe acute cases. Prostration, loss of weight and anemia are progressive and this anemia (from 30 to 75 per cent. in these cases) seems dependent not only on the blood lost in the rectal discharges but on the sepsis of the disease itself. Leucocytosis may or may not be present and in our cases has not been a helpful criterion—varying from 3600 to 13,600. No polynucleosis above 80 per cent. has been seen in these cases even in those with marked peritonitic signs, and often other findings correspond to the duration and severity of the symptoms as to evidences of anemia, dehydration, etc. The abdomen in the cases seen by the surgeon, however, may show a thickened rolling tender colon, either local in the left lower quadrant or diffuse if the disease is extensive, with at times a picture of localized tenderness and rigidity so marked (as in two of our cases), that peritonitic irritation is obvious and perforation or diverticulitis may be suspected.

Sigmoidoscopic examination will establish the diagnosis in practically all of the cases. In a case with twenty or more bloody stools a day and violent rectal tenesmus, such examination may not be easy. Careful manipulation, without force, to avoid possible perforation and preferably under the guidance of the eye as aptly suggested by Crohn, should bring out the diagnosis. The rectum and colon are the seat of an inflammation in which the mucosa is first red and congested with increased watery secretion. It bleeds from a velvety or granular surface on the slightest trauma and fades into normal mucous membrane if any such can be seen. Edema and thickening quickly follow and shortly miliary abscesses appear in the mucosa. With rupture of these, small punched out, bleeding ulcers may be seen or with coalescence of these,

large diffuse ulcers with undermined irregular edges may form and progress more or less deeply into the wall of the gut. Remission with scarring at the base of the smaller ulcers may give rise to the pitted "pock-marked" glazed mucosal surface which is considered by Buie to be pathognomonic of a previous attack or exacerbation of the disease. In the older cases areas of scarred mucosa may show intervening folds of granular inflamed mucosa that strongly suggest polypoid outgrowths from the colonic wall. A similar appearance is sometimes seen in the earlier cases but here seems to be due to the areas of normal mucous membrane jutting out into the lumen of the gut between the surrounding ulcerated areas. The difference between ulcerative colitis and other forms of recurring diarrhoea should be cleared up by the sigmoidoscopic picture.

Pathologically the degree of inflammation may vary most markedly—from the milder superficial inflammation confined mostly to mucosa and sub-mucosa to the very profound phlegmonous type which involves the entire wall of the gut even to peritonitis or perforation. Congestion, oedema, polynuclear infiltration, round cell infiltration will all show in the various layers of the wall of the gut to a degree dependent upon the acuteness of the inflammation. Grossly, as in one case shown here to-night, the colon may be tremendously thickened with the exudative process so that even on compression between the fingers the two succulent friable walls may total a thickness of one to one and one-half inches. The lumen may seem to be practically obliterated. The serosa may be involved to the point of fibrinous exudate and fresh adhesions to the overlying loops of small intestine or even to the parietal peritoneum may be found. As might be expected, oedema and thickening of the mesocolon with enlargement of the lymph-nodes may be present. In the more subacute or chronic forms, however, where round cell infiltration and fibrosis occur in the deeper layers added to the more or less deep ulceration of the mucous membrane, the colon may become a thick walled rope-like tube with oedematous walls, without sacculations, in which a lumen is hard to imagine. Later contraction of the fibrous tissue may lead to narrowing of the lumen which may be permanent and if localized may result in partial bowel obstruction. That complete resolution may occur in the acute cases must be acknowledged. On the other hand, that fatty degeneration of the liver and heart may occur in the cases of long duration must also be acknowledged (due, probably, to the long continued anemia). The possible sequelae in the subacute and chronic cases are interesting for hypothesis. Polyposis and malignancy are recognized as occurring. Knowing the nature of the pathological lesion and the fact that the disease seems to practically always start about the rectum and extend up the colon, is it not also fair to assume that benign annular stricture of the colon and long tubular strictures of the rectum and sigmoid may be logical sequelae of the same disease? It seems to me in retrospect that I have had four cases so explained and personally it is my opinion that the disease ulcerative colitis or proctitis is the causative

factor in many of the tubular strictures of the rectum and colon which have been considered luetic (without proof) or idiopathic. In diagnosis the Röntgen-ray may confirm or elucidate the differential picture. Interference with peristaltic waves so that they are lengthened and more superficial, absence of haustral markings, narrowing due to fibrosis with perhaps eventually stenosis are the essential findings. Local spasmodic stricture will show in some of the acutely inflamed cases. In some of the older cases large areas of ulceration may be brought out in the X-ray film after evacuation of the barium enema from the colon and the immediate light distention of this organ by pumping air into it.

Differential diagnosis with the above aids should separate ulcerative colitis from the ordinary diarrhoeas. The X-ray and sigmoidoscope should also establish the diagnosis between a tuberculous infection of the colon and ulcerative colitis, although the clinical symptoms and physical signs on examination frequently simulate a tuberculous infection. Diverticulitis, malignancy and benign stenosis or stricture may have to be determined.

*Treatment.*—In discussing the treatment of a condition so diverse in its relative intensity and manifestations as is ulcerative colitis, it must be obvious at once that the vast majority of these cases will fall first in the hands of the internist. In reviewing the literature on the subject it is equally obvious from the diversity of opinion as to diet, medication and multitude of solutions used for enemas and irrigations that such treatment by the internist has been unsatisfactory alike to both patient and physician in a large percentage of patients, not only because of the poor response of many cases to even the most carefully outlined treatment but also because of the mortality attending such treatment. In the hands of most competent men such mortality is not without significance as is shown in the reports of various series of cases. (Logan 7.5 per cent.; Lynch and Felson 12.2 per cent.; Albu 14.2 per cent.; Crohn and Rosenberg 6.6 per cent.; Yeoman 5.5 per cent.). However, in this paper no attempt will be made to repeat any outline of medical treatment as such is well covered in the literature. The greatest encouragement medically in recent years seems to have come with the introduction of the dyes, such as acriflavin and gentian violet, for irrigation purposes and the local treatment of such lesions as may be reached through the proctoscope or the sigmoidoscope. In addition to such treatment elimination of possible initiating foci of infection and the use of either a vaccine or vaccine filtrate in such cases as show the Bagen diplococcus may also be instituted.

While these methods may cure or alleviate the mild acute or chronic cases, there will remain a fairly large number of the very acute cases or chronic cases with acute exacerbations in whom surgery must be considered. And if this cellulitis of the colon with redness, edema, swelling and multiple ulcerations and bleeding points were on the body surface in plain sight, I have the feeling that surgical measures would be much more frequently and much more promptly considered. In 1902, Weir is credited with the first appendicostomy performed for ulcerative colitis although the operation had been

This suggested for irrigation purposes by Keetley as far back as 1895. In 1900, Bolton performed the first valvular operation has theoretical advantages but such practical disadvantages that it has become largely obsolete. In 1901, Markoe and Gibson whose idea it was, somewhat later the first transverse ileostomy is credited to Dr. John Brown of St. Louis and has since been done both alone and in combination with appendicostomy for irrigation purposes. Justifying the choice of the involved colon; second, opportunity for irrigation; third, opportunity for closure of the mild type of ulcerative colitis, it provides no exit for the colonic contents and likewise provides very unsatisfactory entrance for irrigation solutions. Ileostomy gives rest to the involved colon most adequately. Complications. Appendicostomy or ileostomy, but as an operation for any open may provide the means for irrigation. Closure of the gut by ileocolostomy at whatever site chosen becomes a fairly formidable operation as a secondary procedure and is certainly not without hazard. Theoretical disadvantages of anastomosis to the lower sigmoid may possibly occur from the blind loop of colon left and the possible inability of the rectum and lower sigmoid to concentrate the stools. Caecostomy done as a liberal opening into the gut (and by this I mean one to one and one-half inches) may be effected through a McBurney incision with attachment of the gut to the peritoneum and parietes at the bottom of the wound without much difficulty. The opening into the gut may be delayed until sufficient adhesion is supplied and after such caecostomy has served its purpose, which may take from a few weeks to three or four months, closure of the shrunken direct caecal fistula can be accomplished as a rule without a formidable operative detail purely to differentiate this type of simple caecostomy, I have gone into detail from a few weeks to three or four place in the treatment of this condition unless used as an adjunct to ileostomy. Theoretically both caecostomy and ileostomy may enhance the possibility of diffuse stenosis of the colon. While benign local stricture is not infrequent, complete obliteration or stenosis is very rare and I find only two such cases mentioned in the literature. The last case so reported by Eichenwald in the *Archiv für klinische Chirurgie* (Berlin, September 26, 1927) was in a boy of fourteen who had had a caecostomy performed twelve years before.

The colon was practically a connective tissue tube with lumen completely obliterated. A successful ileoanostomy was effected. It seems probable, however, in this case that the length of time that the colon had been short circuited in a growing child from age two to age fourteen may have been a determining factor in the connective tissue obliteration.

While the above operative procedure is advocated for the colitis when active, superimposed polyposis, stricture either benign local or diffuse, or malignancy must be treated as sequelae of the disease and make their individual indications for other well chosen operative procedures.

In the present series of cases, nine were operated upon. The procedures used were appendicostomy I, ileosigmoidostomy I, colostomy other than in caecum 3, caecostomy 4. Some of these procedures were unquestionably chosen without a complete understanding of the extent of the pathological lesion. Three deaths occurred—I ileosigmoidostomy, 36 hours post-operative; I colostomy, 8 days post-operative; I colostomy, 10 days post-operative with a profuse hemorrhage from the colostomy opening. Of the four caecostomy operations, all were well but constipated when last seen; two were closed—one acute case at the end of eleven weeks, one subacute case at the end of six months; one disappeared from observation, one wears a colostomy bag and does not wish to stop work for operation. All of these cases, except one appendicostomy and one caecostomy, were severe cases either as acute phlegmonous cases or as acute exacerbations of chronic cases.

*Conclusions.*—Ulcerative colitis is a disease of diverse clinical and pathological manifestations. Its diagnosis and its significance when diagnosed are frequently overlooked.

Diagnosis can be made definitely by the sigmoidoscope or X-ray. The type of inflammation in acute cases strongly suggests a streptococcus or closely allied Bagen's diplococcus as the etiologic factor. Such bacteriological investigation, however, to be valuable must be careful, painstaking and laborious. It must be done by the highly skilled worker. Acute cases, or resistant subacute cases, or chronic cases with acute exacerbations should receive the benefit of surgical treatment promptly. Liberal caecostomy provides adequate drainage, opportunity for irrigation, easy secondary closure. Transfusions, irrigations, topical sigmoidoscopic treatment, and possibly specific vaccine therapy are all aids in the cure of the patient.

# A NEW TYPE OF PERMANENT COLOSTOMY\*

BY CHARLES H. MAYO, M.D.  
AND  
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PERMANENT colostomy is necessarily a fairly common surgical procedure. The idea of an artificial anus is not appealing to the person who should have one, and, unless he is suffering from obstruction when he is told that he has carcinoma of the rectum and that an opening should be made to allow the bowel to empty from an opening in the abdomen, he may choose to have nothing done as long as he can use the anus, reserving colostomy for relief of later obstruction, especially if the local extension, metastasis, or the severity of the disease gives little or no hope of cure. However, he usually accepts the colostomy if it permits eradication of the disease.

In the pre-antiseptic period when it became necessary to make an artificial anus, some surgeons found that the safest place to make it was on the posterior lumbar aspect of the body where the descending colon could often be opened without opening the peritoneum. In this period a structure such as the anus had apparently never been particularly proud of its function and an artificial one was therefore so placed that its remoteness from vision caused no complaint from even the most fastidious folk. When such a condition as carcinoma of the transverse colon existed and a stoma in the ascending colon was necessary as an emergency, liquid faeces passed continually. While the posterior outlet after a Kraskie rectal resection pleased the patient because it was out of sight, it was most certainly never out of mind. It was sentiment and not sense that dictated an uncontrolled outlet.

Mayo Clinic

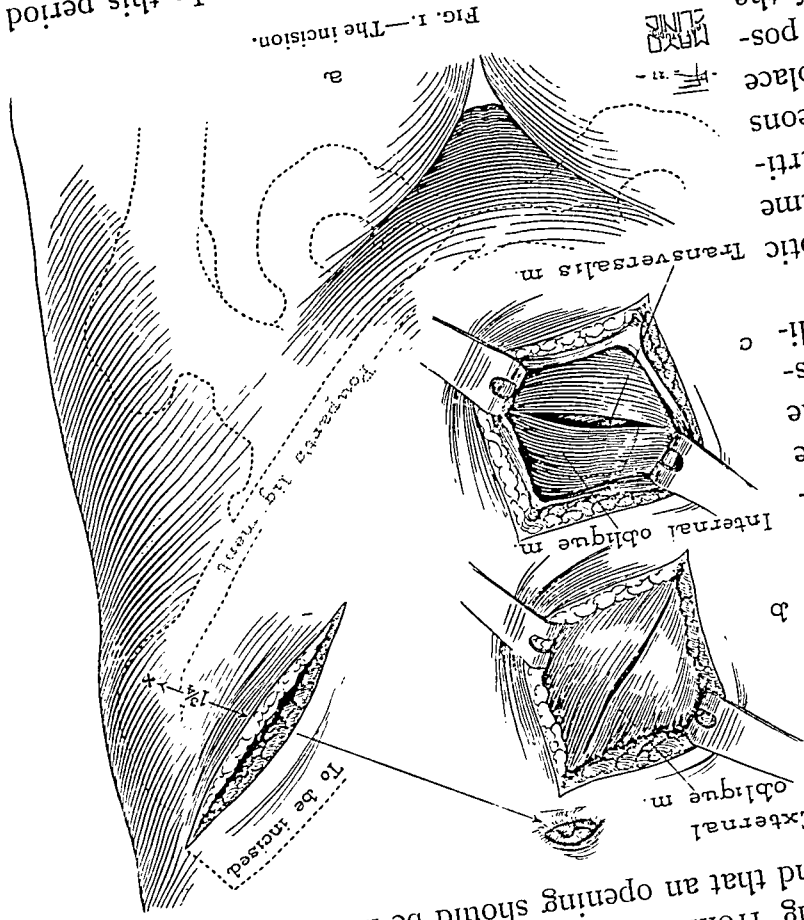


Fig. 1.—The incision.



in the anal region, especially when the sigmoid loop as a fecal reservoir had been lost or shortened. Such a vent was often satisfactory in carcinoma of the anus or lower part of the rectum, which could be excised without opening

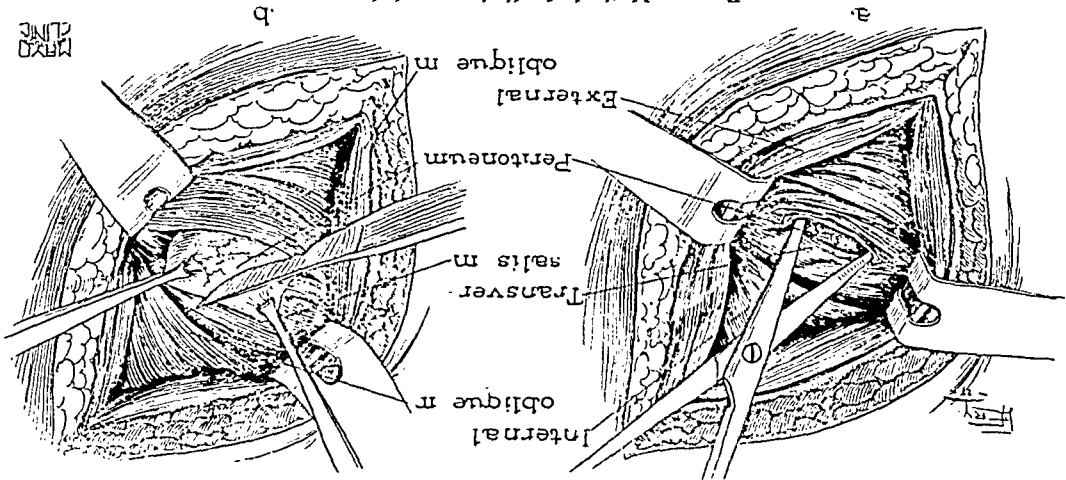


FIG. 2.—Method of splitting muscle layers.

the peritoneum, and without loss of the sigmoid storage function. Many types of colostomy have been described and many of them accomplish the purpose for which they were intended. Some work too well, that is, the

stoma is constantly soiled; in others, the attempt to obviate constant drainage has overreached itself and the stoma has been made in such a way that a great deal of effort is necessary to get it to work freely enough. When the stoma is made as a spur by drawing out a loop of bowel over a sustaining rod, more or less fecal matter passes into the lower part of the

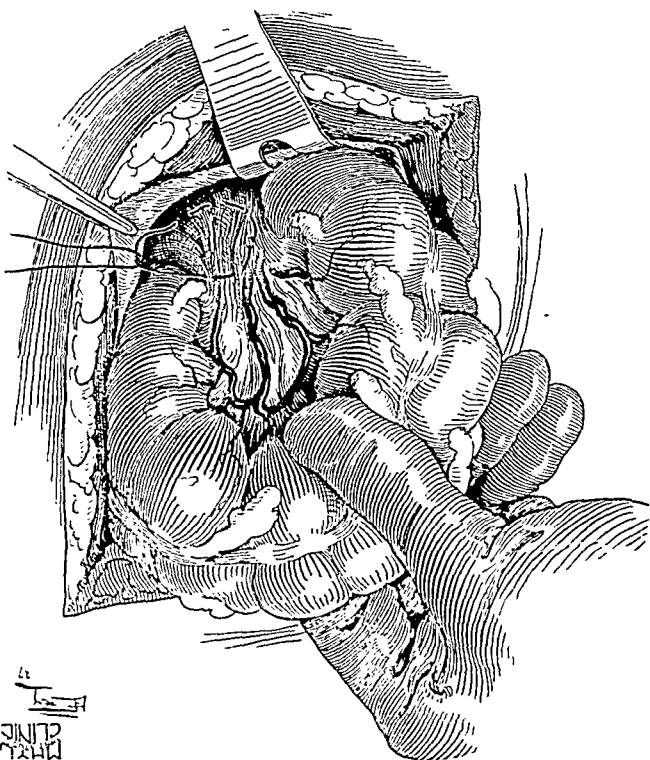


FIG. 3.—Method of obliterating lateral peritoneal pocket.

Unquestionably the ideal stoma, if it can qualify for the use of such an adjective, is one which can be seen and is easily managed and cared for. The anterior stoma is much more satisfactory than the type which used to be made which necessarily carried the patient back to infant life. The type which we are about to describe represents merely a change in

and Poppens,<sup>8</sup> in an extensive experimental study of cholecystoanastomoses, state that the bile-passages become infected in every instance in which union of the gall-bladder and intestine are effected. It obtained following union of the gall-bladder with the stomach or duodenum as well as after anastomosis with the colon. Trautmann, Robbins and Stewart<sup>38</sup> obtained results of the same nature in ten cholecystenterostomies performed on the dog. In each instance intestinal content passed directly into the gall-bladder. In 61 per cent. there was evidence of infection in the bile-passages.

When an internal biliary fistula is established by the spontaneous rupture of the diseased gall-bladder into the intestinal tract, Charcot's syndrome of chills and fever accompanied by jaundice due to the ascending infection of the extrahepatic bile-passages frequently follows. This occurrence is the rule after spontaneous union of the gall-bladder with the colon. Following union with the stomach, duodenum or jejunum symptoms usually ensue that necessitate separation of the gall-bladder from the viscus into which it has perforated, closure of the site of perforation and excision of the gall-bladder. Judd and Burden<sup>12</sup> have recently reported a series of 153 internal biliary fistulae requiring operative relief. Of this number the gall-bladder communicated with the duodenum in 117 instances.

Those who have had a considerable experience with the method in the patient, however, uniformly declare that the danger of infection following cholecystenterostomy is slight. (Bardelben,<sup>3</sup> Mayo-Robson,<sup>21</sup> Kehr,<sup>16b</sup> Babcock.<sup>2</sup>) Certainly the reported instances of cholangitis after cholecysten-

terostomy are few. When the operation is performed for malignancy, however, the rarity with which the complication of cholangitis has been observed, it has been argued, may lie partially in the explanation that such patients do not as a rule survive the procedure long. That the primary mortality is much higher following cholecystenterostomy for obstructive jaundice due to malignancy is well known.<sup>16a, 28, 31</sup> That patients with jaundice due to malignancy do not survive anastomotic operations long has been the experience of most surgeons. In 28 instances reviewed by Kehr in which carcinoma of the bile-ducts or pancreas was present and an internal biliary fistula established by an anastomotic operation, the primary and immediate post-operative mortality was 75 per cent. Mayo-Robson and Cammidge<sup>22</sup> believe that life is not prolonged by any operation in cases where jaundice is due to carcinoma of the head of the pancreas and doubt the justification of its performance.

Rovsing,<sup>35</sup> however, mentions the instance of a patient that survived cholecystojejunostomy for carcinoma of the pancreas causing jaundice fourteen months. An entero-anastomosis was made between the afferent and efferent loops of the jejunum employed in the anastomosis. Kappeler's<sup>13, 14</sup> case survived 14.5 months without apparently developing cholangitis after cholecystojejunostomy. His patient was only comfortable for six months fol-

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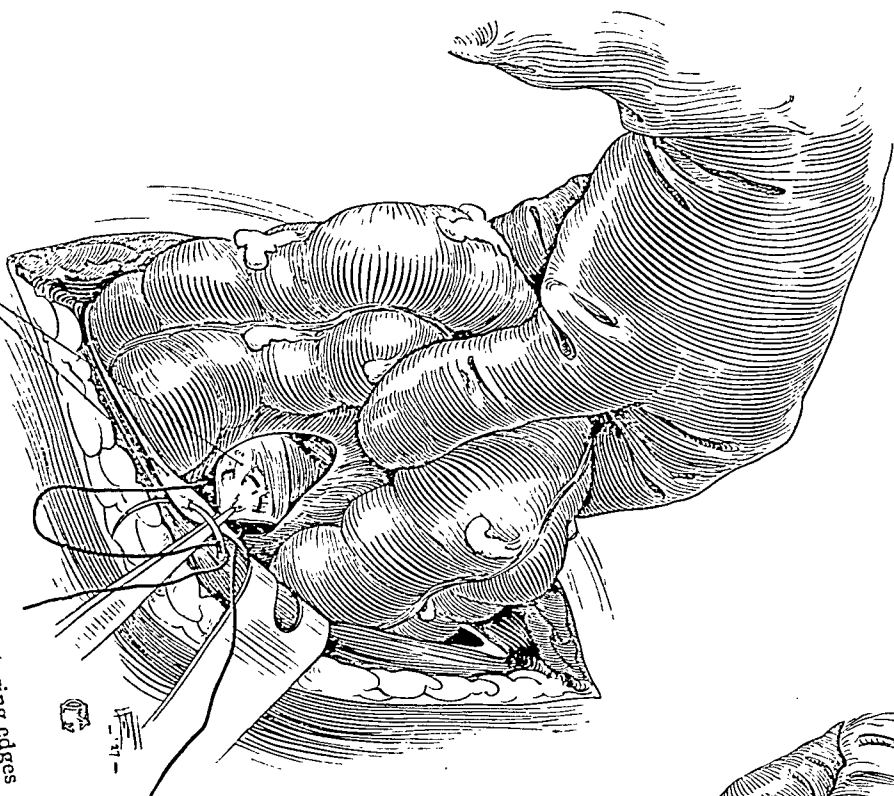


Fig. 4.—Incision of mesocolon and method of suturing edges of peritoneum through opening in mesocolon.

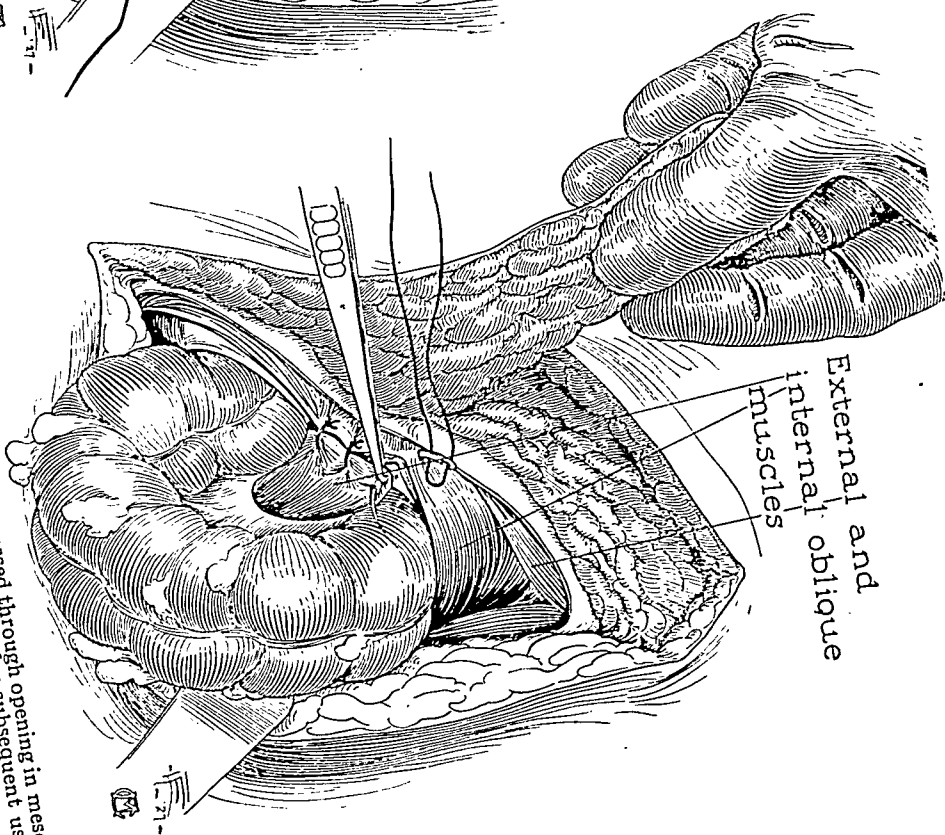


Fig. 5.—Flap of internal oblique muscle passed through opening in mesocolon for suture. The skin flap is shown ready for subsequent use.

External and  
internal oblique  
muscles

technic and not actually a new operation in principle. In this we have endeavored to plan an artificial anus which would give the patient relief from obstruction and at the same time perhaps provide sufficient control so that the patient might take his place in life as before without a cumbersome apparatus or the risk of hernia which its vacuum suction entails.

## DESCRIPTION OF OPERATION

A lower left abdominal incision is made about 10 or 12 cm. in length and about 4 cm. to the mesial side of the left anterior superior spine parallel with

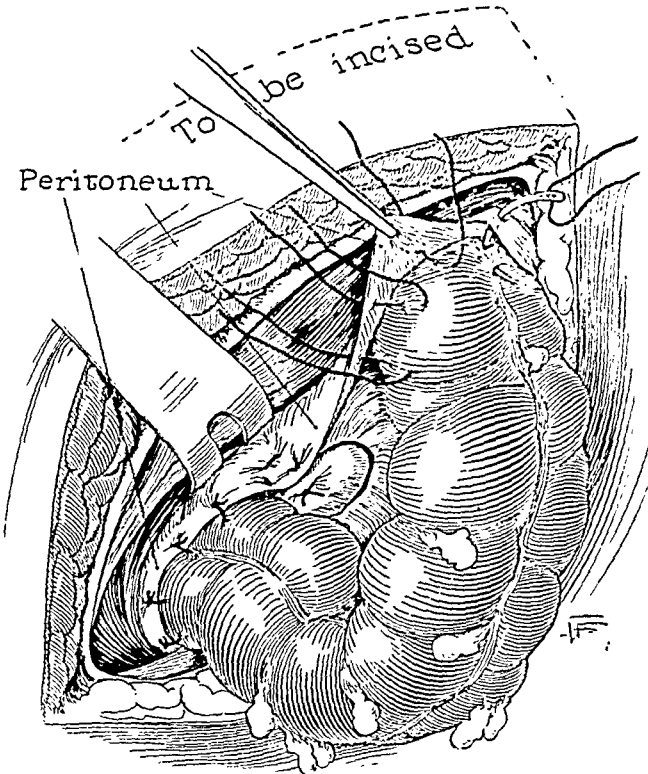


FIG. 6.—Remainder of peritoneum being sutured to sigmoid.

Poupart's ligament. (Fig. 1.) The upper third of the incision extends above the iliac crest. The external oblique fascia is divided in line with the skin incision and the internal oblique and transversalis muscles divided in line with their fibres in the centre of the incision. (Fig. 2a.) The peritoneum is then opened and exploration carried out. (Fig. 2b.) The descending colon is then brought out of the incision with no slack bowel above, as this will prevent possible later prolapse of bowel through the stoma. This also allows sufficient slack below in case poster-

ior resection is to be carried out later. The peritoneal pocket lateral to the sigmoid mesentery is closed by a purse-string suture of the lateral peritoneal fold. (Fig. 3.) This is an important step because if it is not carried out, a loop of the small intestine may herniate by the side of the stoma and become obstructed; death has been known to occur from this complication.

Next, as shown in Figure 4, an opening large enough to pass two fingers is made in the mesocolon. This is made parallel with the vessels as nearly as possible. The original cut edges of the peritoneum are now brought through the opening in the mesocolon and sutured together. The internal oblique is separated from the rectus margin 2 cm. and cut back parallel with the internal oblique fibres 2 cm. This muscle flap is withdrawn to the lateral aspect of the sigmoid, pushed through the opening at the mesocolon and sutured to the edge of the rectus. (Fig. 5.)

# A NEW TYPE OF PERMANENT COLOSTOMY

FIG. 7.—The external oblique has been sutured through the mesenteric opening and is being closed throughout. The skin flap is held in readiness for the next manoeuvre.

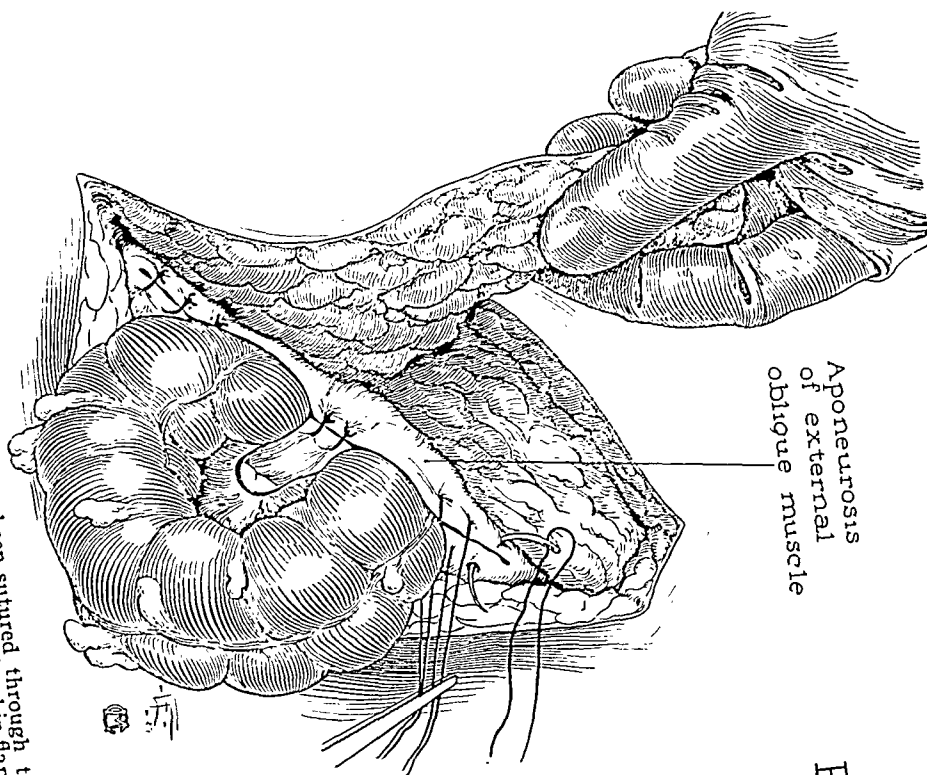
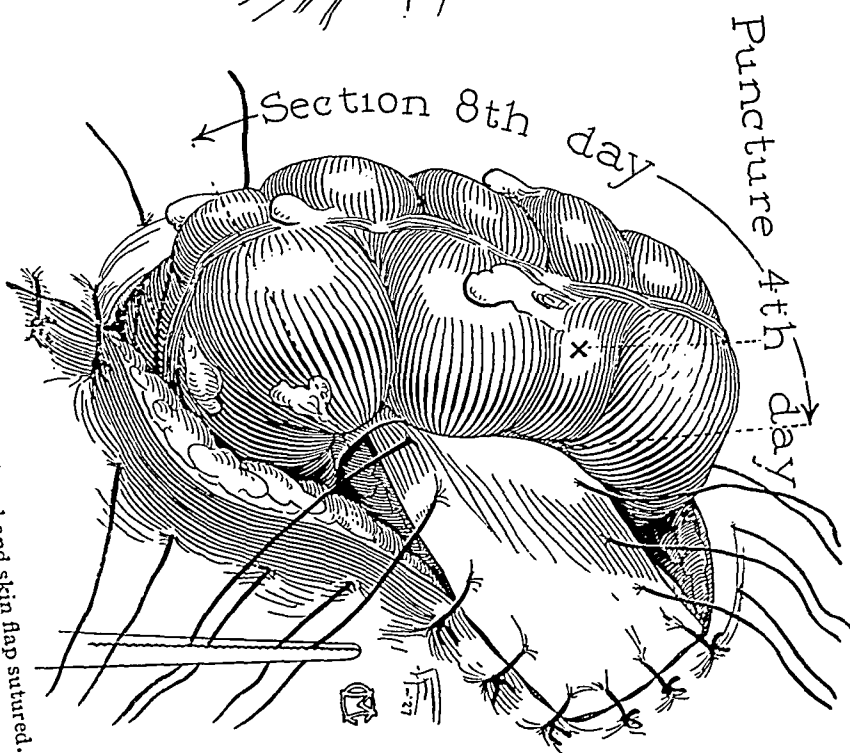


FIG. 8.—Proximal loop displaced and skin flap sutured.



The peritoneum is now sutured with interrupted No. 1 chromic catgut to the colon. (Fig. 6.) This is an important step in any colostomy, since it again guards against the possibility of the small intestine becoming obstructed by working its way into any opening which may be left. The sutures should not be inserted too deeply into the substance of the colon, but placed in thickened areas or where small fat attachments occur on the bowel. The aponeurosis of the external oblique is now closed by means of interrupted sutures (Fig. 7); both sides of the aponeurosis are brought together through the mesocolon and sutured, as were the peritoneum and muscle; hernia is thus prevented.

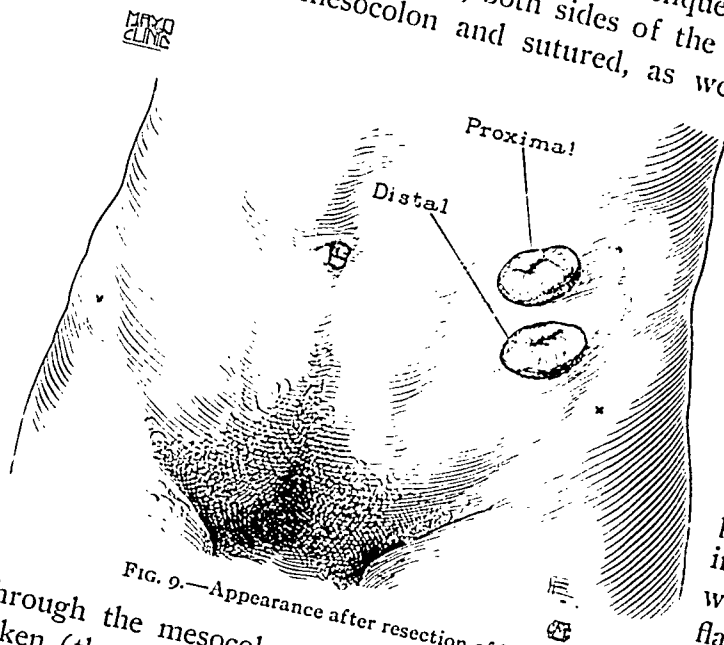


FIG. 9.—Appearance after resection of loop.

The skin flap which is also to be brought through the mesocolic opening is now made by cutting with scissors, as shown in Figure 1; from the upper end of the incision the skin is cut at right angles mesially for about 3 cm., then parallel to the original incision and about half-way its length and the flap lifted with free fat attached. The flap (Fig. 8) is then brought

through the mesocolon, and sutured back to the place from which it was taken (the proximal portion of the loop of intestine being displaced mesially). Interrupted plain catgut sutures are used. On the third or fourth day after operation a small opening is made with a cautery in the knuckle of the colon for the escape of gas. On the seventh or eighth day after operation a wedge-shaped piece of the colon is removed, leaving 0.8 cm. of bowel projecting at each opening. Figure 9 shows the colostomy completed. Two days later the upper loop is irrigated to start elimination. The lower loop should be irrigated three or four times each week. If posterior resection is planned, it is carried out about twelve days after the original operation.

#### CONSIDERATIONS IN PERMANENT COLOSTOMY

If the tumor is not fixed or attached by adhesions to important structures and metastasis cannot be made out in the liver, resection is possible. We are not considering in this paper the cases in which the colon can be reunited after resection and the stoma closed later, but those cases in which a permanent stoma must be established.

The operation is not an emergency one and should not be attempted in the rare cases when immediate relief is imperative. Immediate opening is

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rarely necessary, but, if it is, another operation is necessary for exploration to determine the extent of the lesion and whether or not metastasis has occurred. A greatly distended bowel requires immediate relief without exploration as bacteria are flourishing just beneath the peritoneum and handling causes peritonitis. The abdomen is always carefully explored when the peritoneum is first opened, special attention being given to the liver and then the area of the carcinoma (the lower part of the pelvis in cases of rectal carcinoma) search being made for enlarged lymph-nodes along lower ureteral areas.

In practically all of our cases gas can be expelled through the rectum for several days after the colon is brought up for colostomy according to the method described. This operation had been performed in sixty-five cases up to January 1, 1928. We believe it gives better control than the usual type of colostomy. The muscle passing under the loop of bowel at one angle and the skin flap coming through at another, together with the fascia and peritoneum, exert considerable pressure on the proximal loop of colon, but do not cause obstruction.

In two cases of ours there was a slight slough of the skin flap due to tension. We have obviated this possible objection by placing an ordinary wooden tongue depressor under the loop of bowel after the skin flap has been sutured back in place. This distributes the pressure and tension on the skin, and primary union occurs.

We have had opportunity to see several of these stomas several months afterward and some more than a year later. Most patients use an elastic belt with a small amount of gauze over the stoma covered with toilet paper. Practically all of them have informed us that usually there is one movement from the stoma each morning and occasionally one in the evening. With the skin flap which we have described, the proximal and distal loops are more widely separated than in the usual type; this prevents the fæces from entering the distal loop.

We do not mean to imply that a colonic stoma adds pleasure to one's existence, unless one has endured obstruction, but in certain cases the condition has been made a little more bearable.

# ABDOMINAL INJURIES IN CHILDREN \*

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THE interpretation of abdominal pain in children is no mean task. "Belly-ache" is one of the commonest symptoms associated with the onset of the acute infectious diseases and nasopharyngeal infections. The evaluation of pain in acute appendicitis has in no measure made the mortality statistics of the child comparable with those of the adult. Pain resulting from traumatism to the abdomen, especially when unassociated with evidence of parietal injury is exceedingly difficult to interpret. Our diagnosis is of immediate vital importance only inasmuch as it differentiates between visceral damage, demanding surgical intervention, and abdominal wall injury of relatively small significance.

The pliant frame, thin abdominal wall and delicate omentum of the child are not well-adapted to withstand direct violence, which is transmitted directly to the viscera. A variable degree of shock results either from sympathetic nerve paralysis or rupture of a viscus. Pallor and rapid pulse are not necessarily indicative of shock, for fright may cause an increase of twenty to fifty beats per minute. In an older child, subjective examination is of importance as in the adult, but in a young child with abrasion of the abdominal wall, tenderness and rigidity, the problem is difficult. In a large percentage of instances, the associated injuries complicate the situation.

Children in large centres of population are subjected to frequent automobile and wagon accidents. The resulting casualties result fatally in most instances because of intra-abdominal injury, as disclosed by a study of 149 cases from private practice and the files of the Cook County and Mt. Sinai Hospitals, Chicago. Included in this series, also, were cases in which there was a history of injury to the abdomen from various mishaps. (Table I.)

There were 118 males and 31 females. The major number of accidents came under the heading of automobile and wagon—96 patients, 33 deaths, a mortality of 34 per cent. Children are curious, like to climb, so that falls are common. There were 25 such instances, with 5 deaths, a mortality of 20 per cent. Gunshot or stab wounds, involving abdomen or thorax, were surprisingly common—20 patients, 6 deaths, 30 per cent. mortality.

*Symptoms.*—Generalized or localized *abdominal pain* was noted in every one of the 126 conscious patients. Coma was present in 23; its basis will be explained later. The subjective story in children must be carefully weighed.

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\* The writer is indebted to his former chief, Dr. H. M. Richter, for permission to incorporate in this paper the material used in the section on "Surgery of the Gastro-intestinal Tract in Children," Abt's Pediatrics, vol. iii, pp. 485-503.



## ABDOMINAL INJURIES IN CHILDREN

The power of suggestion is very great. It is frequently desirable to give leading negative questions to be overridden by a positive response. Associated injuries often play an important part. Not infrequently the child with contusion, other than abdominal, complains of belly-ache, the exact origin of which is difficult to explain. Above all, in the examination of the child, one should bear in mind the advice of Dr. H. M. Richter, "the hand and heart of the examiner should be warm."

The incidence of *vomiting* could not be accurately ascertained. It was

TABLE I.

Age	Number of cases	Type of accident	Number of cases	Deaths	Per cent. mortality	
3	4	Automobile accident . . . . .	76	26	34	
4	4	Wagon injury . . . . .	20	7	35	
5	13	Fall {	From roof . . . . .	11	3	27
6	12		Down stairs . . . . .	4	1	25
7	16		On sharp pole . . . . .	3		
8	18		On picket fence . . . . .	2	1	50
9	10		From ladder . . . . .	2		
10	19		From telegraph pole . . .	1		
11	5		On curb . . . . .	1		
12	6		From train . . . . .	1		
13	9					
14	18	Gunshot . . . . .	16	6	37	
15	8	Stab . . . . .	4			
16	7	Kicked in abdomen . . . . .	3	1	33	
Total . . . . .	149	Crushed between vehicles . . .	2			
		Kicked by horse . . . . .	1			
		Crushed by elevator . . . . .	1	1	100	
		Gas explosion . . . . .	1	1	100	
			149	47	31	

recorded in 46 patients by direct observation. Emesis is so frequent in the young that it must have occurred in a considerable number of instances prior to admission to the hospital. No conclusions could be drawn as to the frequency of hæmatemesis, usually resulting from swallowed blood.

*Evisceration* was present in five children. Two had suffered stab wounds, two had been impaled on a picket fence, and in one the abdominal parietes were ruptured in a gas explosion. The omentum was the presenting viscus in two instances, the small bowel in three. Two of the children died.

*Abdominal wall injury* was visible in 87 patients. In 21 the parietes were punctured. More important than these figures was the absence of abrasion, contusion, laceration or puncture in 62. This group will be discussed later.

*Tenderness*, a physical sign, is in no sense synonymous with pain, which is subjective. Local or diffuse soreness was present in 109 children, and absent in 17. *Rigidity* was recorded in 97 instances and was absent in 29. The 23 patients, who were admitted in coma, were not included in this series. No patient, in whom there was an absence of tenderness or rigidity, came to operation. *Distention*, varying in degree, was present in 35 children. Injuries, other than abdominal, were noted in 75 cases. The fractures

TABLE II.

	Diagnosis	Operation	Result
1	Injury to left kidney; fractured ribs.....		Recovery.
2	Injury to right kidney.....		Recovery.
3	Injury to left kidney.....		Recovery.
4	Perforated cæcum, ileum and rectum; subserous hæmatoma of urinary bladder	+	Recovery.
5	Gunshot of chest and left kidney.....		Recovery.
6	Fractured pelvis.....		Recovery.
7	Injury to left kidney.....		Recovery.
8	Injury to left kidney.....		Recovery.
9	Fractured pelvis.....		Recovery.
10	Injury to left kidney.....		Recovery.
11	Fractured pelvis.....		Death.
12	Intracapsular hæmatoma left kidney.....	+	Death.
13	Retroperitoneal hemorrhage; urinary extravasation	+	Recovery.
14	Hemoperitoneum; ruptured ileum.....	+	Recovery.

were—skull 2, spine 2, pelvis 4, clavicle 1, ribs 11, colles 1, femur 1, and tibia and fibula 1.

The *temperature* on admission to the hospital was determined in 131 patients. Subnormal temperature was seen in 21 children (16 per cent.), normal temperature in 30 (23 per cent.) and elevation in 80 (61 per cent.). Of the total series of 149 patients, 99 were admitted to the hospital within one hour of injury, indicating that in the majority of instances fever is to be expected.

Pulse rate was not determined as an aid in early diagnosis. In young children, direct cardiac auscultation is essential, but the rate is greatly influenced by the factors of fright and excitement, as previously mentioned. It is unfortunate that blood-pressure observations were not made in every

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case. The diagnosis of shock can scarcely be made in the absence of definite depression of the blood-pressure. Many children presenting pallor, cold perspiration and rapid pulse showed a decided elevation of pressure. A small

TABLE III.

	Diagnosis (Patients admitted in coma)		Death in
1	Fractured ribs, vertebræ, sacrum and ileum; ruptured right kidney and adrenal; ruptured abdominal wall	Autopsy	1 hour.
2	Huge fresh tear of abdominal wall; multiple lacerations of omentum and intestine	Autopsy	1 hour.
3	Fracture of 3rd to 11th ribs; laceration of liver and spleen; hemoperitoneum	Autopsy	½ hour.
4	Fractured ribs; torn liver, lung, right adrenal; laceration of right heart atrium; free blood in chest, abdomen and pericardial sac	Autopsy	½ hour.
5	Enormous liver laceration and hemoperitoneum . . . . .	Autopsy	2 hours.
6	Liver torn in half; right adrenal crushed. . . . .	Autopsy	2 hours.
7	Rupture of liver and right adrenal; fractured femur . . . . .	Autopsy	1 day.
8	Vertical deep tear of liver; hemoperitoneum; hemothorax..	Autopsy	4 hours.
9	Laceration of left lung and spleen; hemoperitoneum; fractured ribs	Autopsy	2 hours.
10	Hemoperitoneum; ruptured liver. . . . .	Autopsy	½ hour.
11	Internal injuries. . . . .	Clinical diagnosis	1 ½ hours.
12	Internal injuries. . . . .	Clinical diagnosis	2 hours.
13	Internal injuries; suspected fracture of spine. . . . .	Clinical diagnosis	¾ hour.
14	Internal injuries; multiple rib fractures; pneumothorax. . .	Clinical diagnosis	1 ½ hours.
15	Internal injury, hemorrhage and shock. . . . .	Clinical diagnosis	½ hour.
16	Dissection of deep tissues from left thigh and buttock; internal injuries	Clinical diagnosis	5 days.
17	Fractured pelvis; ruptured viscera; hæmaturia . . . . .	Clinical diagnosis	1 hour.
18	Internal injuries; laceration extending through anus and vagina through the fold between the nates to each thigh; deep hemorrhage of the thighs	Clinical diagnosis	10 minutes.

cuff, especially adapted for children, should be in the equipment of institutions, receiving emergency cases.

The *leucocyte count* was determined in 29 patients on admission to the hospital and was definitely increased above normal in 65 per cent. (above

12,000); markedly so in one case (60,000) in the absence of demonstrable visceral injury. In 22 cases, with pathology determined by operation or autopsy, the leucocyte counts ranged from 9800 to 39,600. There was a leucocytosis in three of four patients with abdominal wall injury. No relationship could be demonstrated between the height of the white blood count and the severity of injury. It is unfortunate that an equal number of leucocyte determinations was not made in patients with parietal injury alone, as leucocytosis is commonly present in patients with multiple contusions.

*Hæmaturia*, indicating urinary tract injury, was present in 14 children, as shown in Table II.

*Coma*, on admission to the hospital, was present in 23 patients, of whom 19 died and 4 recovered. Death occurred six hours after operation for repair of ruptured ileum in one child. The four children who recovered were all operated on with the following findings: (1) Rupture of the ileum repaired; (2) hemoperitoneum but injured viscus not demonstrated; (3) ruptured spleen packed; (4) rupture of splenic flexure of colon repaired. Eighteen deaths are accounted for in Table III. Postmortem examinations were secured in 10, while in 8 permission for necropsy was refused. Death occurred within one hour in 9 instances. On the whole the injuries were so extensive that treatment was out of the question.

*Diagnosis*.—In order of importance and frequency the commonest early symptoms in this series of 149 cases were *abdominal pain, tenderness, rigidity, abdominal wall injury, moderate elevation of temperature, vomiting and leucocytosis*. A further analysis of the predominating symptoms reveals some instructive facts relative to diagnosis, the immediate purpose of which is the determination as to whether a watchful policy of expectancy is to be pursued or the patient operated upon at once. The weightiest symptoms are unfortunately those over which the child has considerable subjective control, just as in non-traumatic surgery. Degree of pain is no measure of extent of injury. The differentiation between voluntary and involuntary rigidity must be very carefully made. The decision as to whether local tenderness and rigidity in the presence or absence of abdominal wall abrasion, contusion or laceration indicates visceral damage, must rest upon the associated findings.

In studying the records of 29 children who came to operation, exclusive of cases of evisceration and gunshot wounds, it is evident that the apparent local rigidity and tenderness indicated the exact site of visceral damage in 15 cases and was of no value in 14. The clinical diagnosis was confirmed in 10 instances, was incorrect in 5 and questionable in 14. (See Table IV.)

A review of the records of patients who were autopsied, seemingly indicates that local tenderness and rigidity were of even less value. Visceral damage was correctly indicated in but one case, and local findings were of no value in 14. The clinical diagnosis was correct in only 1 case, was incorrect in 7 and questionable in 7. (See Table V.) However, four of these

lowing the operation, but there is no indication from the facts stated that he suffered from cholangitis. Spannaus<sup>37</sup> credits Kehr with the assertion that he (Kehr) knew of six instances in which the patients survived anastomotic procedures from the relief of obstructive jaundice caused by malignancy for two years or more without symptoms. When the cholecystenterostomy is done in the presence of a patent common bile-duct, it is well known that the newly established stoma frequently closes.<sup>6, 38</sup> Even when the stoma was patent, Archibald<sup>1</sup> was unable to observe the flow of any considerable portion of bile through the fistulous communication in the presence of an unoccluded common bile-duct, in dogs in which he did cholecystenterostomies and isolated a jejunal segment in which to control the observation. Possibly this tendency for the cholecystenterostomy opening to close when the common bile-duct is not occluded may in part account for the infrequency with which the complication of cholangitis has been observed to follow when the operation is performed in patients with an unoccluded common bile-duct and with non-malignant disease, who survive for long periods of time.

In the instance recorded here in which cholangitis developed after cholecystoduodenostomy, the onset of this complication was preceded by influenza. In the patient reported by Kehr,<sup>16b</sup> in which this complication developed, there was also a history of influenza associated with the onset of the cholangitis. Kehr, however, seems inclined to minimize the significance of the influenza as bearing any casual relationship in his case to the infection of the bile-ducts. No culture of the exudate present in the extrahepatic bile-passages was made in either instance. Suppurative cholangitis after influenza has been observed, however, by Mayo-Robson<sup>20</sup> and Rolleston,<sup>34</sup> though no mention of cultural studies was made. Goodhart<sup>9</sup> refers to a patient with influenza who had rigors and intermittent fever similar to that observed in hepatic abscess. In a patient in whom suppurative cholangitis followed influenza, reported by Remy,<sup>33</sup> cultural study of the exudate showed colon bacilli.

Complete obstruction of the common bile-ducts by carcinoma of the head of the pancreas usually gives rise to an afebrile jaundice. When the obstruction has been incomplete, however, cholangitis has not infrequently been observed. Mayo-Robson<sup>20</sup> and Rolleston<sup>34</sup> mention several instances in which intermittent hepatic fever or suppurative cholangitis were observed in carcinoma of the bile-ducts or pancreas. The instances in which cholangitis has developed spontaneously during the course of obstruction of the terminal end of the common bile-duct by carcinoma of the pancreas, appear to be far more numerous than those few instances in which this complication has been observed following cholecystenterostomy for the relief of the obstruction. In each case, the presence of an incomplete obstruction would seem to be the factor that invites infection.

Following reconstructive procedures for benign stricture in the hepatic or common bile-duct, subsequent attacks of jaundice with cholangitis are

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TABLE IV.

Value of Tenderness and Rigidity in Comparison with Operative Findings.

	Site of tenderness and rigidity	Localizing value	Clinical diagnosis	Check on clinical diagnosis	Operative findings
1	Right iliac and lumbar	Positive	Urinary tract injury	Correct	Right retroperitoneal hemorrhage, urinary extravasation.
2	Left lumbar	Positive	Left kidney injury	Correct	Intracapsular hematoma left kidney.
3	Entire abdomen	Negative	Ruptured intestine	Correct	Ruptured ileum.
4	Entire abdomen	Negative	Internal injuries	Incorrect	Hematoma of abdominal wall; no injured viscus.
5	Left hypochondrium	Positive	Pleural hemorrhage	Incorrect	Ruptured spleen.
6	Left lower quadrant	Negative	Ruptured ileum	Incorrect	Rupture splenic flexure colon.
7	Entire abdomen	Negative	Injured viscus	Questionable	Ruptured right lobe of liver.
8	Left lumbar	Positive	Injured left kidney	Correct	Rupture through pelvis of left kidney.
9	Left hypochondrium	Positive	Ruptured spleen	Correct	Ruptured spleen.
10	Diffuse	Negative	Ruptured liver	Correct	Ruptured mesentery and liver.
11	Left iliac	Positive	Peritonitis. Ruptured intestine	Correct	Perforated ileum.
12	Right hypochondrium	Positive	Injured viscus	Questionable	Ruptured liver.
13	Left hypochondrium	Positive	Ruptured spleen	Correct	Ruptured spleen.
14	Left hypochondrium	Negative	Internal injuries	Questionable	Hemoperitoneum; injured viscus not found.
15	Left hypochondrium	Negative	Internal injuries	Incorrect	No findings.
16	Lower quadrants	Negative	Abdominal hemorrhage	Questionable	Torn mesentery. Free blood.
17	Right hypochondrium	Positive	Internal injuries	Questionable	Lacerated liver.
18	Right hypochondrium	Positive	Internal injuries	Questionable	Ruptured right lobe of liver.
19	Right lower quadrant	Negative	Internal injuries	Questionable	Torn transverse colon and mesocolon.
20	Diffuse	Negative	Internal injuries	Questionable	Ruptured spleen.

TABLE IV.—*Continued.*

	Site of tenderness and rigidity	Localizing value	Clinical diagnosis	Check on clinical diagnosis	Operative findings
21	Left iliac	Positive	Internal injuries	Questionable	Lacerated ileum and mesentery.
22	Right half	Negative	Internal injuries	Questionable	Hemoperitoneum, injured viscus not found.
23	Umbilical	Positive	Internal injuries	Questionable	Ruptured ileum.
24	Right iliac and umbilical	Positive	Ruptured ileum	Correct	Ruptured ileum, peritonitis.
25	Epigastric and right iliac	Negative	Ruptured stomach	Incorrect	No findings.
26	Right hypochondrium	Positive	Ruptured liver	Correct	Ruptured liver.
27	Diffuse	Negative	Ruptured viscus	Questionable	Ruptured spleen and pancreas; hemoperitoneum.
28	Left hypochondrium	Positive	Internal injuries	Questionable	Ruptured splenic flexure colon; peritonitis.
29	Diffuse	Negative	Internal injuries	Questionable	Ruptured liver; hemoperitoneum.

Tenderness and rigidity of value in 15 cases; of no value in 14 cases.  
Clinical diagnosis correct in 10 cases, questionable in 14 cases, and incorrect in 5.

patients were admitted to the hospital in coma, and in the remaining eleven death occurred shortly after admission.

Exclusive of the 18 patients brought to the hospital in coma, 97 of the remaining 126 (77 per cent.) exhibited abdominal tenderness and rigidity. This was misleading in four laparotomized children who showed no visceral injury. No child with absence of tenderness and rigidity came to operation, indicating that these physical findings are the most significant diagnostic criteria. In addition, of considerable import is the history of the force applied to the abdomen. Obviously, the history of the passage of a vehicle over the abdomen, or a violent blow, producing mild tenderness and rigidity, is more suggestive of visceral damage than a lighter force resulting in more marked symptoms. Increasing and spreading rigidity is more suggestive of visceral than parietal damage and is more marked with rupture of the hollow viscera and its consequent peritonitis than with laceration of the solid organs and hemorrhage.

The final decision as to whether a given patient demands early laparotomy rests upon a correlation of all the symptoms. Following an initial greater or lesser degree of shock, the picture of a rising pulse, with elevation of temperature, incidence of vomiting, tenderness and rigidity, and the gradual development of distention, suggests rupture of the intestine. The obliteration of liver dulness and the presence of shifting dulness in the flanks are

Value of Tenderness and Rigidity	Localizing value	Clinical diagnosis	Check on clinical diagnosis
Localized . . .	Negative	Myeloma	Check on clinical diagnosis

Sight of tenderness and rigidity		Localizing value	Clinical diagnosis	Clinical diagnosis	Check on clinical diagnosis	Postmortem findings
1	Not localized	Negative	Multiple contusions	Correct	Ruptured liver and spleen.	Ruptured liver and spleen.
2	Diffuse	Positive	Paralytic ileus; peritonitis	Questionable	Ruptured liver and bowel.	Ruptured liver and bowel.
3	Hypogastric	Negative	Ruptured viscus; skull fracture	Questionable	Ruptured liver and peritonitis; ruptured bowel.	Ruptured liver and peritonitis; ruptured bowel.
4	Diffuse	Negative	Skull fracture	Questionable	Ruptured liver and peritonitis; ruptured bowel.	Ruptured liver and peritonitis; ruptured bowel.
5	Diffuse	Negative	Skull fracture	Questionable	Ruptured liver and peritonitis; ruptured bowel.	Ruptured liver and peritonitis; ruptured bowel.
6	Right lower quadrant	Negative	Internal injuries	Questionable	Ruptured spleen, liver and ileum.	Ruptured spleen, liver and ileum.
7	Diffuse	Negative	Internal injuries	Questionable	Lacerated liver.	Lacerated liver.
8	Diffuse	Negative	Multiple contusions	Incorrect	Ruptured ileum; peritonitis.	Ruptured ileum; peritonitis.
9	Diffuse	Negative	Internal injuries	Questionable	Crushed liver.	Crushed liver.
10	Epigastric; right lower quadrant	Negative	Left pneumothorax; skull fracture	Incorrect	Lacerated liver.	Lacerated liver.
11	Diffuse	Negative	Ruptured stomach	Incorrect	Lacerated spleen and lung.	Lacerated spleen and lung.
12	Not localized (coma)	Negative	Internal injuries	Questionable	Hemoperitoneum, ruptured liver.	Hemoperitoneum, ruptured liver.
13	Not localized (coma)	Negative	Internal injuries	Questionable	Lacerated liver and spleen; hemothorax of left lung; fracture of 12 left ribs.	Lacerated liver and spleen; hemothorax of left lung; fracture of 12 left ribs.
14	Not localized (coma)	Negative	Basal skull fracture; internal injuries	Questionable	Torn liver and right lung, right adrenal and heart.	Torn liver and right lung, right adrenal and heart.
15	Not localized (coma)	Negative	Skull fracture	Incorrect	Torn liver and right adrenal.	Torn liver and right adrenal.

minor though valuable signs. Fluoroscopic examination of the abdomen is of great value in determining the presence of free gas in the peritoneal cavity, resulting from intestinal rupture (Vaughan).†

and pancreas, in order of frequency—is attended with massive hemorrhage

† Vaughan, R. T., and Brams, W. A.: Röntgen-ray in the Diagnosis of Perforated Peptic Ulcer. J. A. M. A., vol. lxxxv, pp. 1876-1878, December 12, 1925.

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Peptic Ulcer. J. A. M. A., vol. lxxxv, pp. 1876-1878, December 12, 1925.



and early death. The picture of shock resulting from hemorrhage is more prolonged than in rupture of a hollow viscus. In lesser injuries the bleeding may cease spontaneously, and the clinical course is less stormy than with intestinal rupture. Urinary tract damage is usually accompanied by hæmaturia, though the exact level of injury may be difficult to determine. Early catheterization and cystoscopic examination should not be carried out as the danger of secondary infection is too great.

The discussion of gunshot and stab wounds and evisceration has been

TABLE VI.  
*Operative and Postmortem Findings in Patients Without Abdominal Wall Injury.*

	Operative cases	Result		Necropsies
1	Intracapsular hæmatoma of kidney	Death	1	Ruptured ileum; diffuse peritonitis.
2	Ruptured mesentery and liver....	Death	2	Liver torn in half; right adrenal crushed.
3	Lacerated liver.....	Death	3	Ruptured liver and right adrenal.
4	Rupture of right lobe of liver....	Death	4	Liver and right lung lacerated.
5	Exploratory, no findings.....	Recovery.		
6	Rupture of ileum with peritonitis..	Recovery.		
7	Rupture of splenic flexure of colon; hemoperitoneum	Recovery.		
8	Ruptured liver.....	Recovery.		
9	Hemoperitoneum; injured viscus not found	Recovery.		
10	Exploratory, but no findings....	Recovery.		
11	Hemoperitoneum; torn mesentery	Recovery.		
12	Ruptured spleen.....	Recovery.		
13	Hemoperitoneum; injured viscus not found	Recovery.		
14	Hemoperitoneum; ruptured liver..	Recovery.		

omitted because of the obvious possibilities of visceral injury. A source of error that must not be overlooked is damage to the abdominal viscera, where a bullet enters the chest or thigh at a distance from the abdomen. The possible course of the bullet must be borne in mind. Upper abdominal injury may be confused with thoracic damage. The fluoroscope and in its absence thoracentesis may clear the diagnosis.

The absence of abdominal wall injury can in no sense exclude the possibility of intra-abdominal visceral damage. Thus there was evidence of parietal injury in 87 children, 66 non-penetrating (30 deaths, 45 per cent. mortality), and 21 penetrating (9 deaths, 43 per cent. mortality). Lapa-

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rotomy was performed in 29 instances with 10 deaths, a mortality of 34 per cent. There was no sign of abdominal wall injury in 62 children, and the instances with 4 deaths (mortality 28 per cent.). The abdomen was opened in 14 However, laparotomy is justified whenever there is a reasonable doubt as to visceral injury and the patient's general condition is good. Free blood in the peritoneal cavity does not necessarily mean visceral injury, as hemorrhage from the abdominal wall or retroperitoneal tissues may readily occur.

*Mortality.*—The mortality rate is dependent upon such factors as character of the injury, extent and age of the child. The younger the patient, the more serious the outlook. Hemorrhage and shock are poorly borne by young children. Direct violence to the abdomen may be sharply defined or diffuse. Crushing injuries are of the latter type and are obviously more frequently followed by rupture of solid or hollow viscera. In the series of 149 cases studied, 96, resulting from automobile and wagon accidents, were of this nature. There were 33 deaths, a mortality of 34 per cent. The remaining 53 patients had a death rate of 26 per cent. Gunshot and stab wounds occurred in 20 patients, with 6 deaths, 30 per cent. Gunshot and stab wounds in determining mortality. Evisceration is attended with considerable shock, and the result depends upon the length of exposure and the condition of the peritoneum. In five children, the abdominal viscera protruded. One fell on a picket fence, and the small bowel was exposed for two hours; but the stomach was perforated, and the abdominal wall was ruptured from an hour, within 24 hours. In another, the abdominal wall was ruptured from an hour, to right ilium, following a gas explosion, death occurring within an hour. Three recovered; in two the omentum and bowel were exposed for an hour, in the third the abdominal wall was ruptured 18 hours prior to admission to the hospital.

Death from hemorrhage follows rupture of the solid viscera more frequently than of the hollow organs. Where massive hemorrhage does not immediately cause death, injury to the liver, spleen, kidneys or mesenteric from secondary peritonitis than from hemorrhage. Thus gastric or intestinal perforation must be promptly corrected, as the mortality rises with great rapidity with each hour of delay. Rupture of the hollow organs results fatally, rather than secondary peritonitis. Rupture of the stomach or intestines with involvement of the ileum 6 times, ileum and rectum 1. (Table VII.) There were 6 deaths, Cases 9, 10, 12, 13 and 14 showing extensive injury with death within four hours from time of injury. The promptness of operative treatment was probably a very important factor in the recovery of ten children.

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In the 149 cases there were 43 laparotomies, with 14 deaths (mortality 32 per cent.). After admission to the hospital, operation was carried out within two hours on the average, with the exception of 4 patients; one was laparotomized after 14 hours for rupture of the spleen, another after 32 hours for lacerated liver, the third after 2 days for injury to a kidney, and the

TABLE VII.  
*Results of Operation for Rupture of Stomach or Intestines.*

Case	Organ	Time elapsing from injury to operation	Result	
			Recovery	Death
1	Ileum.....	2 hours	+	
2	Stomach.....	4 hours	+	
3	Jejunum and colon.....	2 hours	+	
4	Ileum.....	4 hours	+	
5	Colon.....	5 hours	+	
6	Ileum.....	3 hours	+	
7	Ileum.....	2 hours	+	
8	Ileum.....	2 hours	+	
9	Ileum and colon (nine perforations).....	2 hours		+
10	Stomach—(abdomen full of blood, protruding omentum and small intestine; stomach contents in abdomen; perforated cardiac end of stomach)	2 hours		+
11	Transverse colon—(injured 18 hours prior to admission)	20 hours		+
12	Stomach—(perforation cardiac end of stomach with omental plug; hemorrhage in lower pole of spleen)	2 hours		+
13	Ileum—(free blood; ileum torn in two).....	4½ hours		+
14	Cæcum and ileum—(perforated cæcum and ileum; right iliac hemorrhage; subserous hæmatoma of bladder; hole in rectum; marked hemoperitoneum)	1 hour		+
15	Colon.....	10 hours	+	
16	Stomach.....	4½ hours	+	
Total .....			10	6

fourth after 9 days for urinary extravasation. There were 33 deaths among the remaining 106 non-operated children (mortality 31 per cent.). In 16 of the 33, death ensued on the average within two hours of admission as the result of extensive injury. (Table III.) The time of death after admission to the hospital is shown in Table VIII for non-operated patients.

The time elapsing from injury to treatment is very important as previously indicated (Table VII.) Admission to the hospital was within one

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hour of injury in 99 cases and within six hours in 135. The remaining 14 children were admitted from 1 to 30 days after accident. The promptness of treatment would lead one to expect a comparatively low mortality rate. The actual figure of 31 per cent. brings home the seriousness of abdominal injury. The complete postmortem examinations of 17 children are listed in Table IX.

*Treatment.*—The treatment of abdominal injury in children, whether parietal or visceral, should first combat shock. In the first hour following

TABLE VIII.

*Time of Death After Admission to Hospital (Non-operated Patients).*

Time	Number of cases
1 hour.....	12
2 hours.....	4
3 hours.....	2
4 hours.....	1
5 hours.....	1
6 hours.....	2
9 hours.....	1
12 hours.....	2
24 hours.....	5
2 days.....	1
5 days.....	1
10 days.....	1

accident, it is often impossible to offer even a tentative diagnosis. Conservative of body heat and a minimum of handling is the best course. The treatment of associated minor abrasions, lacerations or fractures often detracts attention from the essential pathology, adds insult to injury and maintains or increases the picture of shock. Gentle manipulation, external heat, and simple hypodermic stimulation should be the first measures. Morphine must never be employed until the diagnosis is reasonably assured, as its early use may completely hide the true state of affairs.

Non-penetrating abdominal wall injury needs no discussion. Where the parietes have been perforated, it is better to enlarge the wound and explore, than to remain in doubt as to possible visceral injury. In the average case débridement and closure without drainage will suffice.

As a preliminary or sequel to operation no measure ranks higher than blood transfusion. Lack of familiarity with its technic in a large measure accounts for failure in its more general use. Institutions, receiving frequent emergency cases, should have a ready list of available grouped donors.

Matching bloods is a simple procedure of a few minutes' duration. The method of administration is an individual matter. Any method that helps to restore blood volume and substance, maintain blood-pressure, and check hemorrhage, controls shock and saves life. In our experience, citrated

TABLE IX.  
*Postmortem Examinations.*

1	Traumatic ruptured liver and spleen; hemoperitoneum; retroperitoneal hemorrhage; bruises of the head, trunk and thighs.
2	Contusions and abrasions of abdomen, back, hips, thighs, knees; fracture of the ribs, vertebræ, sacrum, ileum; dislocation of lumbar vertebræ; ruptured kidney and adrenal; ruptured abdominal wall.
3	Smoke and dirt begrimed; multiple lacerations and bruises all over the front of the body with many imbedded foreign bodies; huge fresh tear of abdomen.
4	Fractured 3rd to 11th left ribs; laceration of the liver and spleen; hemoperitoneum; hemorrhages of the left lung; abrasions of the face.
5	Traumatic subacute rupture of the bowel; general fibrino-purulent peritonitis; distention of the jejunum and ileum.
6	Crushing laceration of the liver and spleen and parietal pleura; hemothorax and peritoneum; splitting apart of soft tissues of trunk; fat embolism; persistent thymus; status lymphaticus; Frohlich's syndrome.
7	General bruises of the extremities; fracture of 3rd, 4th and 5th ribs; vertical tear of liver and right lung; torn right adrenal; laceration of right heart atrium; free blood in the abdomen and right chest and pericardium.
8	Bruises of the head, chest, back, limbs; liver and spleen torn; small bowel torn across; fractured pelvis; fractured left clavicle; free abdominal blood.
9	Bruising of the upper extremity; enormous laceration and crushing of the liver; fracture of the left 9th rib; free blood in abdomen (3 pounds).
10	Petechial hemorrhages of the face and forehead; liver torn in half; torn right adrenal.
11	Peritonitis following ruptured gut.
12	One-fifth of the liver crushed off from rest of liver, lying loose in the belly; free blood; fractured right 8th and 9th ribs; wounded right lung.
13	Ruptured liver and right adrenal; fractured femur.
14	Vertical deep tear of liver; hemoperitoneum; blood about left lung.
15	Traumatic laceration of lungs and spleen; hemoperitoneum; fractured ribs.
16	Torn lung.
17	Hemoperitoneum; ruptured liver.

blood has been best employed. Intraperitoneal transfusion should never be used in traumatic abdominal emergencies.

The value of transfusion is emphasized when we note that there were 36 children of the series with marked hæmoperitoneum (diagnosis verified by operation in 24 and by necropsy in 12), with 23 deaths. Of definite but less value is hypodermoclysis of normal saline. Where there is a ques-

tion as to rupture of the stomach or intestines liquids by mouth or rectum should be withheld until after operation. It is not the purpose of this paper to discuss operative technic and methods of treatment for injury to various organs, but rather to point out a few general salient points. General anesthesia, adequate incision, gentle

TABLE X.  
Average Time of Death After Rupture of Viscera.

Rupture of solid viscera		Rupture of hollow viscera	
Case	Death within	Case	Death within
1	1/2 hour	1	6 hours
2	1 1/2 hours	2	6 hours
3	2 1/2 hours	3	22 hours
4	3 hours	4	24 hours
5	3 hours	5	40 hours
6	4 hours	6	48 hours
7	4 hours	7	4 1/2 days
8	6 hours		
9	10 hours		
10	12 hours		
11	20 hours		
12	20 hours		
13	24 hours		
14	24 hours		
15	30 hours		
16	72 hours		
17	82 hours		
Average 18.6 hours		Average 36.2 hours	

though rapid manipulation, and conservation of body heat, should form the basis of operation in these children.

Nitrous oxide or ethylene combined with local infiltration of the abdominal wall affords ideal anesthesia. (Crile.) Novocain (1/2 per cent, with one minim 1:1000 adrenalin chloride to the ounce) reduces the amount and length of general anesthetic required, gives excellent relaxation of the abdominal wall, and takes the edge from the early post-operative pain. This method of anesthesia enables the patient to be awake before leaving the operating room and materially reduces post-operative vomiting.

The incision should be adequate, offering ready exposure. Long, drawn-

TABLE XI.

	Operative findings	Operative procedures	Result
1	Nine perforations of small and large intestine; hemoperitoneum	Resection of one foot of ileum; other holes repaired	Death.
2	Herniation of omentum through stab wound; viscera uninjured	Protruding omentum cut off	Recovery.
3	Hemoperitoneum; injured viscus not found	Exploratory laparotomy	Recovery.
4	No findings	Exploratory laparotomy	Recovery.
5	Mesenteric tear; hemoperitoneum	Exploratory laparotomy	Recovery.
6	Protruding omentum and small intestine; perforated cardiac end of stomach; stomach contents in abdomen; hemoperitoneum	Stomach tears repaired; omentum ligated; mesentery sewed; stomach contents removed	Death.
7	Lacerated liver; hemoperitoneum	Liver rent packed with gauze	Death.
8	Rupture of right lobe of liver; free blood	Liver rent repaired with omentum; packs	Death.
9	Torn transverse mesocolon and hæmatoma; torn transverse colon; hemoperitoneum	Tears in bowel and mesocolon repaired	Death.
10	Perforated cardiac end of stomach with omentum plugging hole; hemorrhage in lower pole of spleen	Tear in stomach repaired	Death.
11	Omentum protruding through stab wound	Omentum ligated and cut off	Recovery.
12	Ruptured spleen; hemoperitoneum	Omentum packed into splenic rupture	Recovery.
13	Two lacerations of ileum and mesentery	Tears in ileum and mesentery repaired	Death.
14	Hemoperitoneum; no injuries found	Exploratory laparotomy	Recovery.
15	Ruptured small intestine; hemoperitoneum	Ileum repaired	Recovery.
16	No findings	Exploratory laparotomy	Death.
17	Retroperitoneal hemorrhage and urinary extravasation	Extraperitoneal removal of blood clot	Recovery.
18	Protruding omentum	External omentum ligated and cut off	Recovery.
19	Eighteen inches of eviscerated bowel (normal)	Bowel replaced	Recovery.
20	Intracapsular hæmatoma of left kidney	Kidney incised, clot removed and kidney replaced	Death.
21	Hemoperitoneum; effusions in mesentery	Exploratory laparotomy	Recovery.

usually synonymous with recurrence of the stricture. The Kehr T tube which can be left *in situ* for a long time in this respect, exhibits a decided advantage over the catheter which slips away before the scar tissue at the site of repair has ceased to contract. If stricture formation reoccurs cholangitis obtains in spite of a functional sphincteric insertion of the terminal common bile-duct into the duodenum. In anastomotic operations in the nature of hepatico or choledochenterostomy, undoubtedly one of the important factors that operate to prevent more uniform and permanent successes with the method is the tendency for the anastomotic opening to close. Probably, only in the event of obstruction to the flow of bile through the new stoma does the potential infection in the bowel actually become a menace.

## SUMMARY

That potential infection is real following cholecystenterostomy is shown by the regularity with which it occurs in the experimental animal. The necessity for operative relief following spontaneous union of the diseased gall-bladder and upper intestine indicates that the procedure is not to be selected for internal drainage of diseased bile passages. The complication of cholangitis in patients following cholecystenterostomy has only infrequently been observed. Those who have had a considerable experience with the method uniformly agree that the danger of subsequent infection is slight. An instance in which this complication was observed is reported. It would appear that narrowing or partial occlusion of the stoma as occurred in this instance following anastomotic operations of the upper reaches of the intestinal tract with the bile-passages is the important factor in determining whether the complication of cholangitis will follow. Cholecystenterostomy is an operation of real value in the treatment of an irremovable obstruction in the common bile-duct.

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# ABDOMINAL INJURIES IN CHILDREN

TABLE XI.—*Continued.*

	Operative findings	Operative procedures	Result
22	Ruptured ileum with distal segment thrombosed and inflamed; hemoperitoneum	Ileostomy; ileal perforation sutured	Recovery.
23	Hæmatoma of abdominal wall; no injured viscus	Exploratory laparotomy	Recovery.
24	Lacerated left lobe of liver; free blood	Liver tears sutured	Recovery.
25	Perforation cardiac end of stomach; and left lobe of liver; hemoperitoneum	Perforations in stomach repaired	Recovery.
26	Three perforations of jejunum; one perforation of mesentery; five perforations of colon; small amount of feces and free blood	Intestinal openings sutured; one ounce of ether poured into abdomen	Recovery.
27	Ruptured small bowel with free fluid and marked plastic free peritonitis	Laceration repaired	Recovery.
28	Ruptured spleen	Spleen packed	Death.
29	Rupture of splenic flexure of colon with free blood	Exploratory laparotomy	Recovery.
30	Ruptured edge of right lobe of liver	Exploratory laparotomy	Recovery.
31	Ruptured pelvis of left kidney; torn mesocolon; retroperitoneal urinary effusion	Left nephrectomy; repair of mesocolon	Recovery.
32	Ruptured spleen	Splenectomy	Recovery.
33	Ruptured mesentery and liver; free blood	Exploratory laparotomy	Death.
34	Perforated small bowel; free pus	Ileum sutured	Recovery.
35	Ruptured liver; free blood	Exploratory laparotomy	Recovery.
36	Transverse rupture of spleen; much free blood	Omentum placed between torn edges of spleen	Recovery.
37	Two perforations of ileum	Perforations of ileum sutured	Recovery.
38	Perforated cæcum and small bowel; subserous hæmatoma of bladder; perforated rectum; marked hemoperitoneum	Suture of perforations; drainage	Death.
39	Rupture of liver about falciform ligament; marked hemoperitoneum	Suture of rupture	Recovery.
40	Spleen lacerated and almost completely detached from pedicle; tail of pancreas separated from body; marked hemorrhage	Splenectomy	Death.
41	Ruptured splenic flexure of colon; diffuse peritonitis; paralytic ileus	Perforation in colon closed; jejunostomy; drainage	Recovery.
42	Rupture at right side of dome of liver; marked hemorrhage	Exploratory laparotomy; blood transfusion	Death.
43	Two perforations of stomach	Suture of holes	Recovery.

out dissections of the abdominal wall must be classed as bad surgery. This step in laparotomy should be the most rapid. Where definite localization is present, the place of incision is obvious. Exploratory incisions are best made above the umbilicus, median or paramedian. In 27 patients injury involved viscera of upper abdomen in 20 instances, of lower abdomen, in 7.

Injury to the solid viscera, when extensive, is rapidly fatal because of hemorrhage, hence the abdomen should be opened as soon as the diagnosis is made, and the anæmia offset by blood transfusion. Drainage, after repair of liver, spleen, kidney, mesentery or urinary bladder, is seldom, if ever, necessary. Packing of a laceration is a valuable procedure that involves an entirely different principle than drainage. In pancreatitis drainage is essential.

Injury to the stomach or intestines does not usually result fatally because of hemorrhage, unless associated with laceration of the solid organs. The danger from peritonitis is many times as great, so that each hour of delay increases the mortality. Table X shows that the average time of death after injury was 18.6 hours following rupture of the solid viscera in 17 children, and 36.2 hours after laceration of stomach, ileum or colon in 7 patients.

The fixed points of the intestine, duodeno-jejunal flexure and ileocæcal junction are most frequently ruptured, hence the examination should begin from these points. More than one rent in the bowel may be present. Needless evisceration is very harmful. Gross food or fecal matter should be removed, but prolonged toilet of the peritoneum is detrimental. Before suture of the perforation is begun, the integrity of the mesenteric circulation should be ascertained. At times a temporary ileostomy or colostomy may be a life-saving measure, where the condition of the patient will not warrant a necessary resection. Drainage should be determined by the presence of gross suppuration alone; this will rarely be necessary except in delayed cases. As the infectivity of the bowel increases toward the colon, drainage will more often be found necessary in injuries of the colon and rectum. Practically the only exceptions to the rule of non-drainage is exposure of the retro-peritoneal tissues, as in rupture of the posterior duodenum.

The findings in the 43 operated patients are listed in Table XI.

#### SUMMARY AND CONCLUSIONS

1. The study of 149 cases of abdominal injury in children indicates that the commonest early symptoms in order of importance are abdominal pain, tenderness, rigidity, abdominal wall injury, moderate elevation of temperature, vomiting and leucocytosis.

2. The mortality rate is dependent upon such factors as character of the injury, extent and nature of visceral damage, time elapsing from injury to treatment, and age of the child.

3. The early combating of shock, blood transfusion, combined local and general anæsthesia and adequate incision are important factors in successful treatment, in addition to the specific repair of the damaged viscus.

4. Laparotomy is justified whenever there is a reasonable doubt as to visceral injury, and the patient's general condition is good.

# OPERATIVE MORTALITY AND END RESULTS IN GALL-BLADDER SURGERY

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THE author's first paper on gall-bladder surgery was read before the section on Surgery and Anatomy when the American Medical Association met in New Orleans in 1903, and was a plea for cholecystectomy. As an indication of my trend of thought at that time, permit the quotation of a single sentence from that paper: "After a gall-bladder has been as profoundly diseased as it usually is when made the object of surgical attack, it never regains its normal state and is henceforth not only valueless, but on account of its defective drainage is constantly subjected to the risks of fresh infection." At that time the so-called radical views expressed were made the object of a sweeping criticism by John B. Murphy, A. J. Ochsner, W. J. Mayo and others.

Before the Nebraska State Medical Association, in 1921, a summary was made of 563 cases of gall-bladder operations. About one-half of these cases were subjected to cholecystectomy and the other half were drained. The operative mortality of this series was 8.17 per cent. Since that time there has been a gradual reduction in the mortality and a steady increase in the number of removals of the viscus.

In the present communication I submit a later experience in which it has been attempted to make as close an analysis as possible of the causes of the operative mortality, and the reasons for failure to cure all the cases. To this end 160 consecutive cases of gall-bladder surgery are hereby submitted for study.

There are 132 females in the series and 28 males, or a little more than four females to one male. There were six operative deaths, or 3.75 per cent. mortality. It may prove profitable to analyze the deaths and endeavor to discover how some of the fatalities might have been prevented. Of the 160 operations, 156 cholecystectomies were performed and only 4 cholecystostomies, or in 97.5 per cent. of the cases operated on the gall-bladder was removed. Two of the deaths followed cholecystostomy. This is not meant to be an argument for the greater safety of cholecystectomy, but to show that drainage is resorted to only in the very serious cases.

*Analysis of the Operative Deaths.*—Death No. 1. The first death in the series was a cholecystectomy done for cholecystitis and was a very easy case and there was no anxiety about the outcome. The patient was a strong man, he did well for a few hours, then developed a streptococcic sore throat with acute abdominal pain and succumbed four days later of streptococcic peritonitis, confirmed by blood culture and autopsy. This was just at the beginning of an outbreak of streptococcic sore throat among nurses and patients and all operations except cases of extreme emergency were suspended in the hospital until the epidemic was at an end.

Death No. 2, was a woman, aged fifty-seven, with extreme jaundice. She had a

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mass extending across the upper abdomen and the diagnosis was in some doubt. The operation was exploratory in character. The mass was found to be an acutely inflamed pancreas and there was an extremely thickened gall-bladder which was simply drained with the hope of helping the pancreatitis. She did well for four or five days; then began to weaken and died of exhaustion thirty-one days after the operation.

Death No. 3 suffered from an acute empyema of the gall-bladder with many stones in its cavity, and she had a septic temperature, the operation being undertaken because she was rapidly losing ground. The cystic duct was so brittle that it broke off when I manipulated the gall-bladder before deciding what was the best procedure. The hemorrhage was extreme and so much trouble was experienced in trying to secure the bleeding artery that I was forced to pack the wound to control hemorrhage. She did fairly well until seven days later, when the packing was removed. The removal was followed by a severe hemorrhage of which she died immediately.

Death No. 4 was Mrs. N. F. H., age seventy-two, very weak from long-continued sepsis due to an empyema of the gall-bladder which also contained stones. Cholecystostomy was done in this case, the operation being carried out as rapidly and gently as possible. She did splendidly for thirteen days and had begun sitting up when she died suddenly of what was pronounced an acute cardiac condition, though no autopsy was permitted.

Death No. 5. Mrs. N. K., aged fifty-eight. This was a case of cholelithiasis with dense adhesions of the gall-bladder to the stomach and hepatic flexure of the colon. There were some difficulties in the operation, and the raw surfaces where adhesions had been loosened were inclined to ooze so that two cigarette drains were introduced. She died of general peritonitis seven days after the operation. The autopsy showed everything intact about the stump of the cystic duct and the liver surface. Looking over the hepatic flexure from which the adherent gall-bladder had been loosened was gangrenous, and this was regarded as the source of the peritoneal infection. Looking backward upon this case the question naturally arises, if I had contented myself with a cholecystostomy instead of a cholecystectomy would this woman have recovered? Many times adhesions equally firm have been loosened with no untoward result and there seemed no reason to expect disaster here. Again was it an error to introduce the cigarette drains and may not their presence have caused the necrosis?

Death No. 6. A man, aged sixty, had been losing flesh and strength for several months and was considered an uncertain surgical risk, but he was getting progressively worse and was suffering much distress from a subacute cholecystitis. Cholecystectomy and appendectomy were accomplished easily and there was no shock. Patient did fairly well for the first thirty hours and then died of a heart condition which was attributed by the doctors who observed him as a thrombosis of the coronary artery. As there was no autopsy this point can never be definitely decided.

Summarizing these six deaths, one died of septic peritonitis during an epidemic of streptococcic sore throat; the second from exhaustion thirty-one days after a drainage operation on a woman much jaundiced and with acute pancreatitis; the third, empyema of the gall-bladder, the one in which the cystic duct and artery snapped off and who died of hemorrhage when the pack was removed; the fourth, also empyema of the gall-bladder, which was simply drained, did well, was sitting up and succumbed to a cardiac death thirteen days after operation; the fifth, who died of general peritonitis, resulting from gangrene of the hepatic colon from which the gall-bladder had been dissected; the sixth a rather frail man who apparently died of a coronary thrombosis forty-eight hours after a simple cholecystectomy and appendectomy.

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Looking back on these six deaths, it is easy to criticize. My mind is perfectly easy concerning the first, second, fourth and sixth. Had I been content to simply drain the third case the disaster of breaking off the cystic duct and artery and the later death from hemorrhage might have been avoided, but my experience of reoperating such cases, for their symptoms nearly always continue or return when the condition is so serious, has been such that I think anything short of cholecystectomy does not cure permanently. For this reason my gall-bladder surgery only seldom stops short of elimination of the viscus. The fifth case, the one of gangrene of the colon, is open to discussion.

*Analysis of the End Results.*—Of the 154 cases that recovered from the operation, to all of whom a questionnaire was sent, answers were received from 144, and many of these were seen and personally examined. Our notation of the end results will therefore perforce have to be based on the 144 on whose condition we have information.

In order that we may have a common understanding of the results, let it be understood that I am classifying the end results as follows:

1. Cured, if there are left no symptoms to remind the patient of his old trouble.
2. Relatively cured, if the patient is relieved of all the more disagreeable symptoms, but is occasionally reminded of his former trouble by belching or fulness of the stomach.
3. Improved, when there are still disagreeable symptoms, but they are definitely less than before the operation.
4. Not improved, if patient reports himself as no better than before, or if, on examination it is found his symptoms have not been improved.

A glance at the following table will show the results gleaned from the answers to the questionnaire:

Number of answers received .....	144
Number of cures .....	100, or 69.4 per cent.
Number of relative cures .....	31, or 21.5 per cent.
Number improved .....	7, or 4.9 per cent.
Number unimproved .....	6, or 4.2 per cent.

There has been a question whether the cases with gall-stones do not offer a better prognosis than when gall-bladder infection is present without stone. So small a series does not mean much, but it is offered for what it is worth:

Number cases of cholelithiasis .....	69
Number cures .....	55, or 79.7 per cent.
Number relative cures .....	10, or 14.5 per cent.
Number improved .....	3, or 4.3 per cent.
Number unimproved .....	1, or 1.5 per cent.
Number cases of cholecystitis .....	75
Number cures .....	45, or 60 per cent.
Number relative cures .....	21, or 28 per cent.
Number improved .....	4, or 5.3 per cent.
Number unimproved .....	5, or 6.7 per cent.

To those critically inclined I suppose too large a proportion of the operations are for cases of cholecystitis and I am inclined to agree with such a criticism. The fact that the percentage of cures of the cases of cholelithiasis is 79.7 and of the cases of cholecystitis only 60 per cent. gives food for thought. Am positive that a definite inflammation of the gall-bladder existed in all the cases classified as cholecystitis and all were verified by the pathologist; but the question in my mind is, was other pathology responsible for the symptoms in some of the cases? Neurological conditions may account for some of the incomplete cures. It is very manifest that no diagnostic aid should be omitted in order to avoid unnecessary operations when the gall-bladder is under suspicion.

Now we are reaching the main object of this paper, which is to find an answer to two questions: (1) How may the operative mortality of gall-bladder operations be still further reduced? (2) What pathology prevents complete cure, and can the type of operation improve the end results? A low mortality depends much on the selection of the proper time for operating and a careful preparation of the patient for the ordeal. Let it be understood here that there is no contempt too great for the surgeon who refuses operation on the very ill patient because he is afraid it will increase his mortality. The very ill, the desperately ill, must be cared for, but he must not be operated until the ultimate has been accomplished in preparing him for the operation.

At the present time no surgeon with proper regard for his patient would think of an operation until the case has been studied from all standpoints, the more important bodily functions estimated, and the patient put into the best possible condition. This means a careful diagnosis not only of the gall-bladder itself, but of the patient as a whole. The gall-bladder function and the kidney function must be studied, the condition of the heart and lungs must receive due attention, an intimate knowledge of the arterial system, including the blood-pressure and a careful estimation of the coagulability of the blood must be included as a pre-operative routine.

The diagnostic methods have been greatly improved in recent years. In cases of doubtful diagnosis we have in the Graham-Cole test and the Van den Bergh test definite aids which should always be made use of. Cholecystography, as we make more and more use of it, has been steadily increasing in value as we learn better how to interpret its findings. With experience it is possible to learn more and more the ability of each gall-bladder under inspection to concentrate bile and to estimate its elasticity as revealed by its power to empty after the ingestion of a fat meal. Besides this the shape and size of the viscus is well shown by the Graham-Cole test, its contour being affected by a difference in the elasticity of the different segments of its walls, or by distortions due to adhesions to neighborhood viscera. The more the Van den Bergh test is used and the more carefully its findings are analyzed, the more evidence is gained for it, especially in borderline cases and in those with complications. Repeated tests are necessary to

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avoid falling into error. It not only measures the degree of jaundice, but by its variation from day to day it is a reliable indicator of the progress of the disease and aids materially in helping to estimate the jaundiced individual's status as a surgical risk. An increasing amount of bilirubin in the blood indicates that operation at this time would be extrahazardous; while definite lessening of the bilirubin indicates a more favorable time for operative intervention even before the jaundice has begun to fade.

For a long time it has been apparent that if accurate knowledge of the condition of the liver could be determined, it would give the surgeon a means of estimating the tolerance of the patient to surgical trauma and would also furnish a better basis for determining beforehand the degree of relief that might be expected from a cholecystectomy.

Unfortunately the many and varied functions of the liver are so little understood and the many suggested tests for these functions so inadequate that thus far they have been of very little practical benefit. Our meagre knowledge of the real functions of the liver and the extreme doubt of the trustworthiness of the proposed functional tests make a pre-operative evaluation of the condition of the liver a matter of grave uncertainty.

As McVicar says, "The liver is a complex workshop housed with many activities." Any of the tests, even if correctly interpreted, gives information only of a single function. If that function is found to be normal, other equally important functions may be out of commission. Let liver function be studied as much as possible, because of valuable knowledge it may lead to, but to follow blindly these tests as a guide to gall-bladder operations will only invite disaster and involve one in uncertainty.

Before operating on the very ill subject of gall-bladder disease a kidney functional test and a careful computation of blood urea-nitrogen will furnish the means of preventing some mortalities. A careful study of the integrity of the heart muscle is also very important.

In preparing the patient for operation, it is most essential that the tissues be most generously supplied with fluids for at least two days beforehand. Much glucose per oram and by the Murphy drip before and after these operations has saved many lives. After operation on a depressed patient a few hundred c.c. of 10 per cent. glucose intravenously is a favorite remedy in my hospital service. It is a cardinal principal to fear dehydration as one would fear the plague and every safeguard is made use of to avoid such a calamity.

The anæsthetic is a question of much importance. Ether anæsthesia, if the patient's condition is good, may be administered, using the minimum amount necessary to affect good anæsthesia. If the patient is much depressed, local anæsthesia is much preferred. A favorite method is to use a local anæsthetic for opening the abdomen and then a few whiffs of gas while completing the intra-abdominal part of the operation, the gas administration being stopped as soon as the gall-bladder is out.

It is my opinion that post-operative shock, morbidity, mortality and end results may all be greatly improved by systematic and extreme gentleness in handling tissues during the operative procedure. The use of local anæsthesia is the best method I know of to train surgeon in art of gentle operating.

Perfect hæmostasis has become such a watchword among modern surgeons that it is scarcely necessary to mention it at this time. Every drop of blood possible to be saved for the patient during the operation should be saved. Intra-peritoneal oozing after the operation is over is calamitous for two reasons: it weakens the patient and it is a fruitful cause of post-operative adhesions and thus prevents complete cures.

It is my conviction that post-operative adhesions are more responsible than any other factor in leaving these patients only partially cured. The most glaring fault in gall-bladder surgery in the past has been the reckless use of gauze and cigarette drains. Every drainage case, if the drainage is unnecessary spells needless adhesions, the adhesions being directly proportional in volume to the volume of the drain. Do not misunderstand my position. I do not go so far as to say that these gall-bladder cases should never be drained, for occasionally in spite of all we can do, there is still some oozing from the liver surface, or there may be some other complication that makes it desirable to drain, but in the average case the wound may be closed without drainage with perfect safety and when this is done the immediate convalescence is smoother and shorter and the end results better.

Other things being equal the longer gall-bladder disease has been present the more neighborhood pathology will be found. First and foremost the liver suffers from pathology secondary to gall-bladder infection. Seldom, as Graham has so clearly pointed out, do we find a diseased gall-bladder without hepatitis. The liver is notoriously able to repair itself, but many of these old cases of cholecystitis show a liver with so much deposit of fibrous tissue that it would be unreasonable to expect it to become wholly normal, even after the source of its pathology, the gall-bladder, has been removed.

Many gall-bladder infections are accompanied by cholangitis, even the smaller biliary ducts are so distorted by inflammation that they can never be expected to become normal. Unquestionably unrelievable liver pathology is the cause of many of the cases of gall-bladder surgery being followed by incomplete cures.

The pancreas is another organ that is early affected by infection of the gall-bladder. Pancreatitis of less or greater degree of severity is an almost constant complication of cholecystitis. If the gall-bladder is removed early before irremediable changes in the pancreas have occurred, the more chance will there be that all disagreeable symptoms will disappear.

Some striking experiences have profoundly impressed me that all the train of rheumatic symptoms attributed to focal infections in general are derived from the infected gall-bladder more frequently than generally supposed. Several personal experiences bear out this belief; cases with rheumatic pains, valvular heart lesions and all the other dire consequences of



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infection: who have had their tonsils removed, their teeth extracted, their sinuses drained with no benefit, have cleared up promptly after removal of an infected gall-bladder.

In conclusion it seems reasonable to believe that with increasing knowledge in selecting the time for surgical intervention, increasing experience in operating, a fuller appreciation of the value of gentleness in manipulation of tissue, and a more general appreciation on the part of the profession in general that an infected gall-bladder produces complicating pathology in direct ratio to the time it is allowed to spread infection, will do much not only in reducing the operative mortality, but will greatly increase the proportion of cases completely cured.

# DIVERTICULA OF THE BLADDER

REMARKS FOUNDED UPON A STUDY OF TWELVE CASES

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DIVERTICULUM of the urinary bladder has ceased to be a rare finding as a result of the more universal application of cystoscopy and cystography in lesions of the lower urinary tract. This improvement in the diagnosis has shown diverticula to be present in from five to seven per cent. of cases seen during the prostatic age. Trabeculae and small saccules are frequently seen in cases presenting obstructive symptoms, whereas the diagnosis of true diverticulum of the bladder is limited to those cases possessing a distinct orifice with herniation of the entire bladder wall and excludes such anomalous conditions as urachal cysts, hour-glass bladder, etc.

Much contention has existed in the past as to the cause of diverticula. The early writers attempted to classify diverticula as true and false, depending on whether or not the sac contained muscle fibres, but the work of Rose and others has shown that this attempted classification is erroneous. It is now generally agreed that diverticula have both congenital and acquired factors for their development. Recently Hyman collected a series of thirty cases of diverticulum in children. Three of these were his own and presented no demonstrable obstruction to the outflow of urine. Judd, Young, Watson, Hyman, Gardner, Crosbie, and Rose are of the opinion that congenital factors play an important rôle in the development of diverticula. The fact that diverticula are often seen in children and occasionally found in the fetus, and in females with no apparent urinary obstruction, as was found in one case in this report, shows that there is a congenital predisposition to such formation. LeComte reported a case of true diverticulum in a young man with no obstruction present. The acquired factor depends on urinary obstruction for its development and is usually seen during the prostatic age. The fact that diverticula are seen more frequently in men shows that prostatic obstruction is one of the principle acquired causes. Judd says diverticula are rare in females, having seen but two cases in a large series from the Mayo Clinic. Pugh in a recent report of one hundred collected cases found twenty-five per cent. were under forty years of age.

*Location.*—The most common site for diverticula is at the upper and lateral margin of the trigone, especially in the region of the ureteral orifice. Occasionally the ureter becomes incorporated in the wall of the sac. Frequently in cystoscopying a prostatic we see multiple cellules of varying depths, as well as marked trabeculation of the bladder as a result of back pressure. Unless

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the obstruction is removed these cells often herniate through the bladder wall and result in diverticula. As long as drainage is adequate and infection is absent the diverticulum is of no clinical importance. Residual urine accumulates as a result of obstruction, and sooner or later produces urinary distention as well as renal insufficiency.

*Symptoms.*—There are no symptoms pathognomonic of vesical diverticula.

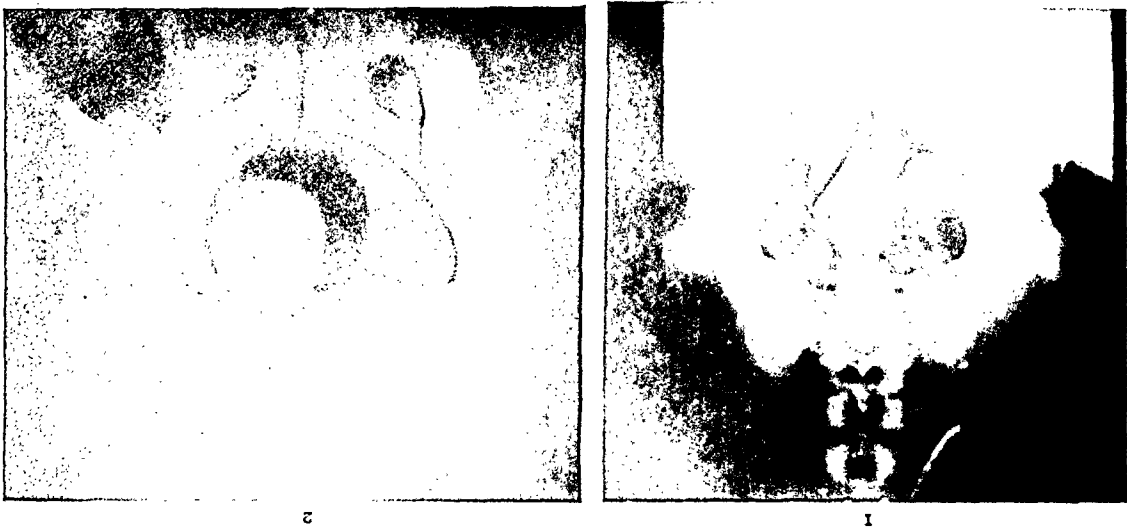


Fig. 1.—Recurrent dumbbell stone in bladder and associated diverticulum. Stone removed and diverticulum resected.  
 Fig. 2.—Contrast cystogram showing diverticulum filled with opaque solution. Catheter in bladder. Black shadow shows air in bladder. This method shows the inability of such a diverticulum to empty.  
 Fig. 3.—A contrast cystogram showing the presence of two diverticula. The bladder was filled with air subsequent to the injection of sodium iodide solution.  
 Fig. 4.—Cystogram of adult female with urethral stricture. The diverticulum and associated cellulites held thirty-two ounces of solution.

However, the patient frequently complains of inability to completely empty the bladder, i.e., ability to pass an additional quantity of urine after the bladder is thought to have been emptied. As the majority of diverticula are seen during the prostatic age, the symptoms are those of obstruction to the outlet of the bladder. Frequency of urination, together with inability to completely empty the bladder and the passage of foul urine, constitute the most common symptoms of this condition. Three patients in this series were able to pass an additional quantity of urine after the bladder was

## STIRLING AND ROLLINGS

thought to have emptied. Ten of the patients had foul, cloudy urine and complained of some difficulty and pain on voiding as a result of the cystitis. Often the symptoms of benign prostatic overshadow those of diverticulum so that the patient is frequently unaware of the presence of a diverticulum. Hæmaturia is occasionally seen as an accompanying symptom, especially in the presence of a new growth.

**Diagnosis.**—Cystoscopy in competent hands affords a very accurate method of determining the presence of a diverticulum. The size, number, location, and relation to the ureteral orifice can usually be ascertained by this method. While in some cases of prostatic obstruction cystoscopy is contra-indicated, it is very necessary to determine whether or not calculi and diverticula are present before one is warranted in proceeding with a prostatectomy. A plain urogram should always be made of the urinary tract. This precludes the

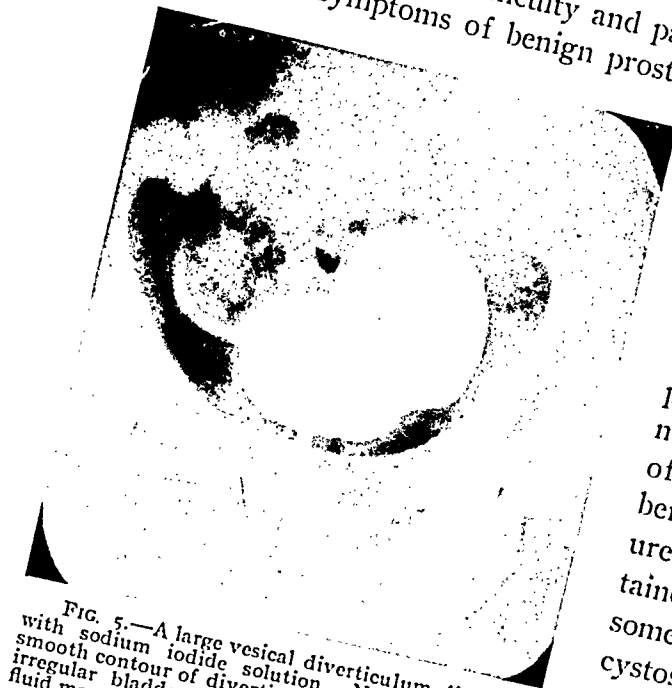


FIG. 5.—A large vesical diverticulum distended with sodium iodide solution. Note contrast in smooth contour of diverticulum compared to rough irregular bladder outline. Some regurgitation of fluid may be seen in right ureter.

Gardner reports three cases of benign prostatic on the urinary tract. This precludes the possibility of overlooking a stone in the ureter, kidney, or in a blind diverticulum as was done elsewhere in one case herein reported. The cystoscopic findings should always be corroborated by cystography, as the latter is more accurate in determining the exact size, and whether or not the diverticulum empties completely. One should not rely on the cystoscopic diagnosis alone, as the size of the diverticular orifice is no criterion as to the capacity of the sac. A series of three or more plates should be made in doing a cystogram, consisting of an antero-posterior view, a lateral view to show the retrovesical type, and one after the bladder is emptied to see if retention in the sac occurs. A contrast cystogram filling the bladder with air after draining the sodium iodide solution aids in the diagnosis. It is often impossible to estimate the position of a retrovesical sac from an antero-posterior radiogram. A

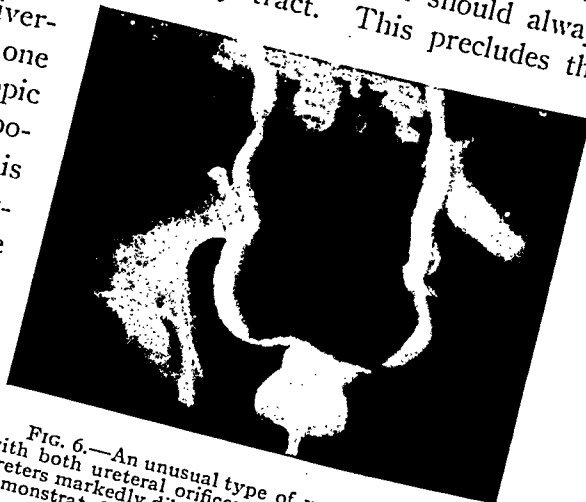


FIG. 6.—An unusual type of vesical diverticulum with both ureteral orifices emptying into it. Both ureters markedly dilated. No obstruction could be demonstrated.

five per cent. solution of sodium iodide is an excellent medium for outlining the sac by cystography. Stone is occasionally seen in a diverticulum and may be entirely overlooked by cystoscopy if the calculus is located in the sac alone. One case in this series had a dumbbell stone situated both in the bladder and diverticulum, which had been overlooked at cystoscopy elsewhere, and the patient made worse following an operation by another surgeon, because he was not radiographed. A point that we wish to emphasize at this time in the diagnosis of this condition is the value of an opaque catheter coiled up in the diverticulum as well as a lead catheter



FIG. 7.—Stereoscopic plates with opaque catheter coiled in diverticulum, a second in the ureter. By this method one is able to determine the relationship of a diverticulum to the affected ureter.

FIG. 8.—Large vesical diverticulum seen in antero-posterior view.

in the ureter on the affected side. This enables one to form a definite idea as to whether or not the ureter is incorporated in the diverticulum. It also serves as a guide in removing an adherent diverticulum which is adjacent but not included with the ureter.

*Treatment.*—Hunt says that a diverticulum of an ounce or more capacity

with retention and inadequate drainage should be treated surgically. Diverticulum is of no clinical importance as long as infection and residual urine are not present. If the orifice of the diverticulum is large, and the sac so situated that retention does not take place, palliative measures may be tried. Read has suggested division of the constricting ring at the orifice in those cases where resection is not advisable. He says that this affords better drainage of the sac. In the presence of residual urine and infection it is imperative that the diverticulum be resected in order to get good functional results following prostatectomy. No particular method of removal can be used in the different types of diverticula. Intravesical removal of small diverticula is quite feasible as suggested by Young. However, where a large

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sac is present, it can best be removed by extra-vesical resection. Lower advises packing the sac with gauze before resection is attempted. This converts the sac into a solid tumor which facilitates removal. The method of removal which we have most frequently practiced is the following: After the bladder has been opened, a finger is introduced into the diverticulum and traction applied from within the sac. This facilitates separation of the sac from the rather loosely attached surrounding structures. Blunt dissection is carried down to the neck of the sac, which is then divided and removed. The bladder opening is closed with a Pezzar catheter in the suprapubic incision. A rubber tissue drain is inserted to the site of the sac. If the ureteral orifice is incorporated in the diverticulum, transplantation of the ureter to another portion of the bladder may be done. Herbst says many of the cases with poor functional results following prosta-tectomy are due to diverticula being overlooked at the time of operation.

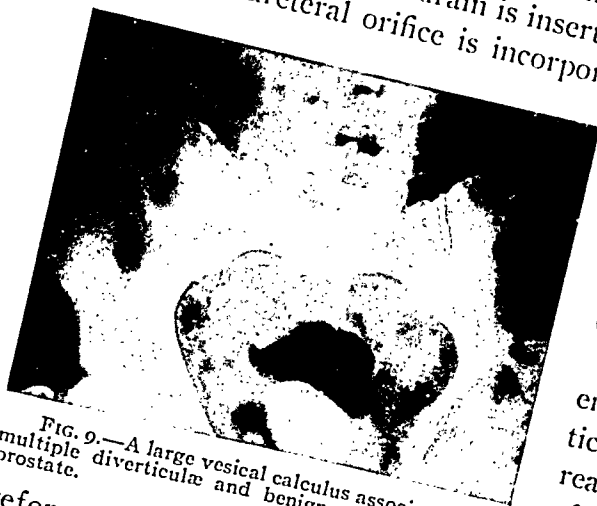


FIG. 9.—A large vesical calculus associated with multiple diverticulæ and benign adenoma of the prostate.

*Associated Lesions.*—The presence of residual urine in a diverticulum with subsequent infection readily lends itself to the production of calculi. Two cases in this group had large vesical calculi present, one being dumbbell in type which had accompanying diverticulum. Fifteen cases in the presence of diverticulum alone. New cases in this group had large vesical calculi present, one being dumbbell in type which had accompanying diverticulum. Fifteen cases in the presence of diverticulum alone. New cases in this group had large vesical calculi present, one being dumbbell in type which had accompanying diverticulum.

reformed from a calculus located in an accompanying diverticulum. Fifteen per cent. of the cases reported by Judd and Scholl had stone as an accompanying factor. Nine of these stones were found in the diverticulum alone. New growths may occasionally be seen in the presence of diverticulum as occurred in one case in this group. The literature shows an increasing number of cases in which carcinoma was found associated with a diverticulum. A plain X-ray should be taken in all cases in order to rule out metastasis. This may prevent an unnecessary operation.

*Summary of Cases.*—Six of these cases presented unusual features. The first, a relatively rare dumbbell type stone in bladder and diverticulum; second, a diverticulum of the bladder associated with a diverticulum of the ureter; third, an enormous diverticulum with eight associated diverticula present which held thirty-two ounces; fourth, a large diverticulum of the bladder of a female without obstruction; fifth, a diverticulum of the bladder with both ureteral orifices opening in it, associated with enormous hydro-ureters and hydronephrosis; sixth, a large vesical calculus associated with two diverticula of the bladder. Seven of the twelve cases were operated on successfully; three cases being inoperable as a result of cardio-renal disease; the remaining two had palliative treatment. One of the most striking observations of this study was the relative proportion of females to males. Four of these cases occurred in females.

The last four cases were seen during the past two weeks, two being seen the same morning. Of the last three cases, two were females and neither had any symptoms referable to the urinary tract, showing that diverticulum may exist without the patient being aware of its presence. Lack of time precludes the possibility of reporting all twelve cases; however, seven have been selected that represent the various types of case.

# ILLUSTRATION OF CASES

CASE I.—J. C. K., male adult, aged sixty-three, was first seen June 7, 1925. Chief complaint was difficulty and pain on urination, together with nocturia. Past history, essentially negative. Patient has been having disturbance of urination for the past three years, gradually increasing in severity until at the present time he finds it necessary to arise from three to six times during the night to void. Rectal examination shows moderate prostatic enlargement. Cystoscopic examination showed marked trabeculation together with a diverticular opening situated lateral and superior to the right ureteral orifice. Some intravesical protrusion of the prostate was noted. An opaque catheter was coiled in the diverticula which measured four cm. in diameter. The patient was decompressed with an indwelling catheter for ten days after admission to the hospital. The diverticulum was then resected by intra-vesical inversion after the method of Young, the neck ligated and the opening closed with catgut. A relatively small prostate was also removed at this time. Convalescence was uninterrupted, and the patient discharged five weeks later, cured. Subsequent history normal.

FIG. 10.—Opaque catheter in diverticulum which was found associated with the vesical calculus.



CASE II.—Mr. C. L. N., white, male adult, age sixty-five, referred by Doctor Davies of this city. Entered hospital, June, 1925, complaining of intense tenesmus, frequency of urination, and haematuria. Past history, negative. The urinary symptoms gradually increased in severity, especially when the patient was on his feet. The pain, dysuria, and the presence of blood in the urine caused him to seek medical attention. On May 20, 1918, a cystoscopy was done elsewhere and the diagnosis made of stone in the bladder. Following this operation the patient was unable to void and had been catheterized for the past seven years. His former symptoms returned, and a second cystoscopy was done by another urologist. Patient was advised to have an operation but refused. We saw the patient May 2, 1925, for the first time. He was in severe pain, requiring morphia for relief. Vesical tenesmus was most marked and he complained of inability to empty the bladder. A plain X-ray showed a large dumbbell stone in the bladder and connecting diverticulum. The patient refused a cystoscopic examination. He was advised to have the diverticulum and stone removed, which was done. The two stones were united and it was necessary to fracture the junction in order to remove each half. The diverticulum was then resected. There was no demonstrable enlargement of the prostate. This case supports the congenital theory of diverticular formation as the patient had no prostatic enlargement. He had had the diverticulum over a period of ten years or more. The



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reformation of the stone which apparently had not been recognized as a dumbbell one at the first operation, was the cause of the return of symptoms.

CASE III.—Mrs. Mary B., colored, female, age sixty-six, first seen November 10, 1925. Chief complaint, difficulty and pain on urination. Past history, irrelevant to present complaint. Patient has been having difficulty in voiding for the past ten years. The symptoms were intermittent in character. No blood or stone had been noticed. The difficulty in urinating had become so pronounced that she came to the hospital for relief. Cystoscopic examination showed a large diverticulum situated lateral and slightly superior to the right ureteral orifice. The diverticular opening was equal to that of the scope could be passed in to the diverticulum. A cystogram was not done due to the bladder. The urine was very foul and turbid. Physical examination showed a marked infection and poor condition of the pulse, probably as a result of the long-standing toxic myocarditis with irregularity of the pulse. The patient left the hospital at her own request and was told to return at intervals for treatment. She died several months later, probably as a result of the urosepsis. No obstruction was found present in this case, the urethral lumen being normal. This case shows that diverticulum may be occasionally seen in the complete absence of urinary obstruction and was probably congenital in origin.

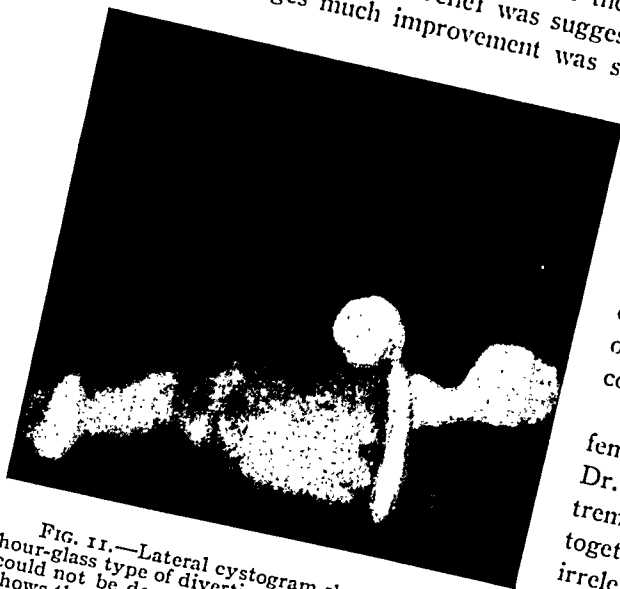


FIG. 11.—Lateral cystogram showing an almost hour-glass type of diverticulum. This diverticulum could not be demonstrated antero-posteriorly, but shows the value of a lateral plate.

resulted in almost continuous pain in the bladder region. Shortness of breath and cardiac decompensation occurred probably as a result of urinary sepsis. Urinary examination revealed the presence of an almost impassable urethral stricture. This was gradually dilated and irrigation of the bladder caused a marked amelioration of her symptoms. Cystoscopic examination showed an enormous diverticulum of the bladder with smaller sacs incorporated in the larger one. A cystogram was done and demonstrated the upper margin of the diverticulum on a level with the brim of the pelvis. The bladder and sac held thirty-two ounces of very foul turbid urine. There has been very marked improvement in the cardio-vascular condition with no shortness of breath and she has been able to resume her normal activities. Resection of the sac has been suggested, but in view of her improvement it has been deferred to a later date.

CASE V.—Mr. Joel J., male adult, age eighty-seven, was seen July, 1926, in consultation with Dr. Louis Mackall. Chief complaint was difficulty in voiding and hæmaturia. Patient gave a history of falling astride a buggy wheel sixty-five years ago, rupturing the urethra at the peno-scrotal junction. An attempt at catheterization resulted in false passage. An external urethrotomy was done and a tube left in the urethra for several weeks. This was followed by a permanent urinary fistula which would only admit a child cystoscope. The urine was bloody and very foul. A diagnosis was made of carcinoma of the bladder. Under local anæsthesia the bladder was opened and the tumor

found incorporated in the orifice of a diverticulum located lateral to the left ureteral orifice. The tumor was destroyed by the radio knife and the constricting ring of the diverticulum divided. Convalescence was uneventful. An X-ray study revealed metastasis in the pelvic bones, which resulted in his death three months later. Resection in this case was obviously contra-indicated due to the metastasis.

CASE VI.—Mr. S. L., white, male, adult, age sixty-six, seen July, 1927, in consultation with Doctor Carrio. Past history was negative. Chief complaint, difficulty in starting and stopping urination with nocturia. For the past five years patient has had to get up five or six times at night to void. This was accompanied by pain and the passage of but small quantities of turbid urine. Rectal examination revealed a moderately enlarged prostate. Cystoscopic examination showed a larger diverticulum lateral and slightly superior to the right ureteral orifice. An opaque catheter was coiled in the sac and another catheter inserted in the right ureter, followed by stereoscopic plates. This was done in view of the intimate connection of the diverticulum and right ureteral orifice. The X-ray study showed the ureter to be several millimetres anterior to the sac. A cystogram was made and showed the diverticulum to be larger than the bladder. The prostate was enlarged intravesically. The diverticulum was resected extravesically at the first operation, followed by a prostatectomy two weeks later. Recovery was uninterrupted and the patient has been seen at frequent intervals and is free from residual urine, nor has he had any return of his former symptoms.

CASE VII.—Mr. W. M. L., white, male adult, age forty-eight, seen June 15, 1927, in consultation with Doctor Meyers. Chief complaint, pain in suprapubic region with some difficulty in voiding, plus hematuria. For the past year has noticed that when he is on his feet the pain is increased, as well as the bleeding. Gets up from one to three times at night to void, with occasional sudden stoppage of urinary stream. The urine is also blood-tinged after long rides in automobile or when riding horse-back. Patient says urine has been very cloudy for past two or three years with a rather foul odor. A plain X-ray shows a large oval calculus in the bladder area. A rectal examination shows no appreciable enlargement of the prostate gland. Patient refused to be cystoscoped. Physical examination shows a robust, well-developed man of low mentality. Kidney excretion and retention test normal after ten days drainage of bladder with an indwelling catheter. This was followed by suprapubic cystostomy under ethylene. The large stone was removed and two diverticular orifices located lateral and inferior to each ureteral orifice. The orifices were large enough to admit a small finger. A cystogram made several days later showed a large diverticulum almost hour-glass in character. This was resected after the method described by Geraghty. Convalescence normal.

# SUMMARY

1. Diverticulum of the bladder occurs in from five to seven per cent. of patients reaching the prostatic age.
2. Congenital factors play an important rôle in the etiology of these cases. Obstruction at the bladder outlet converts these potential hernias into a true diverticulum.
3. In the presence of residual urine and infection, resection offers a good prognosis in operable cases. The obstruction should be removed at a subsequent operation.
4. Cystoscopy in conjunction with serial cystograms affords a very accurate method of diagnosis and should be practiced in prostatics unless definite contra-indications exist.

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CONGENITAL HYPERTROPHY OF THE INTERURTERAL RIDGE  
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ANASTASIA W. LASKOWICKI, M.D.

The publications of Wesson and Young on anatomy of the trigone of the bladder attracted the surgeon's attention. The case defined as Hypertrophy of the trigone of the bladder and associated disturbances and surgical treatment.

The publications of Wesson and Young on anatomy and physiology of the trigone of the bladder attracted the surgeons' attention to a new type of disturbance defined as hypertrophy of the Intervertebral Ridge which leads to urinary cases of this rare disease described hitherto concerned with obstruction of urination. The etiology of this disease has not been sufficiently explained as before. According to the anamnesis showed that the youngest patient was 39 years of age (Blanc's youngest patient was 39 years of age) and the anamnesis showed that the disease had been present since birth. According to the anamnesis showed that the disease had been present since birth.

[illegible]

The patient was 39 years old, and in most of these cases obstruction caused by a small fibrous contraction of the bladder, or that the interureteral ridge is a long contracted ridge which causes obstruction. According to Hinman and Wesson supposed that the most likely cause of the hypertrophy of the interureteral ridge is a long contracted ridge which causes obstruction. All cases of urinary retention explained as yet.

[illegible]

These writers suppose that this pathological state can be congenital, recently observed by anybody, not, so far, been observed by anybody. However, recently I had observed a case of congenital hypertrophy of the bladder itself (interstitial) however, that a case of congenital hypertrophy of the bladder itself (interstitial) has been observed by anybody.

however, that a case of congenital hypertrophy of the bladder itself (tuberculosis). I have not, so far, been observed by anybody. However, recently I had occasion to observe a case of the interteral ridge beyond doubt.

No. 216 1925/26.—Ph., male, aged twenty-five. At the age of twenty-two he felt stinging pain in the intervertebral ridge where the fact of its being congenital seemed beyond doubt. However, recently I had occasion to observe a case of hypertrophy of the intervertebral ridge (tuberculosis). The bladder itself (tuberculous state) can be congenital, they add, but the hypertrophy of the intervertebral ridge has been observed by anybody.

[illegible][illegible][illegible][illegible][illegible]

The patient remained at the clinic for internal diseases for ten days after the catheterization. The quantity of urine emitted with in 7 days was quite normal, excepting low specific weight (1003). On the day of admission the urine was quite normal, excepting low specific weight (1003). The patient remained at the clinic for internal diseases for ten days after the catheterization. The quantity of urine emitted with in 7 days was quite normal, excepting low specific weight (1003).

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...four hours amounting to  
...injection of the amount  
...of urine were  
...he was

the temperature increased, and the urine became troubled. The patient was sent for examination and further treatment to the surgical clinic.

The cystoscopy showed: The neck of the bladder and the trigone were lifted up considerably and were covered with *œdema bullosum*. The orifice of the ureter and of the vesical neck could be seen within one sight-field (Marion's symptom). The bladder wall was trabeculated, above both orifices of the ureter two openings of two diverticula were seen, the mucous membrane of the bladder inflammatorily changed, also numerous

pieces of fibrin were seen. The interureteral ridge was distinctly prominent and thickened, with a deep pouch behind, the bottom of which could not be seen. The prostate was not enlarged, of a soft consistency, and in one place in the left lobe a little hardened.

After the catheter was put into the bladder, the urine flowed out in a strong stream which could be intensified by the patient. The examination of the blood showed 110 milligrams of nitrogen in 100 cubic centimetres.

The diagnosis involved mechanical obstruction of urination. On account of some topographical changes (Marion's symptom), *i.e.*, on account of the vesical neck being drawn nearer to the orifices of the ureters, as well as because of the trigone being con-

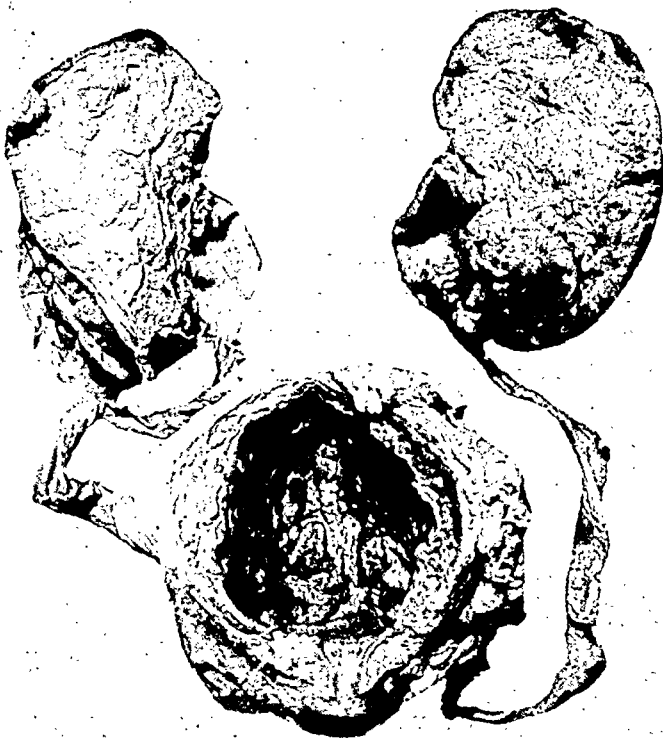


FIG. 1.—Showing changes in wall of bladder, ureters and kidneys.

siderably lifted up, it was suspected that there was a sarcoma of the prostate growing into the bladder (*œdema bullosum*). The hypertrophy of the interureteral ridge, the existence of the diverticula and the obstruction of urination we explained with changes which we supposed had taken place in the prostate.

The patient was catheterized every morning, and the bladder rinsed with a solution of 1:1000 *argentum nitricum*, after which the patient did not urinate the whole day, in the evening only he felt the necessity of urinating, and urinated then (*i.e.*, at night) 10 to 15 times in small quantities.

On December 15, cystoscopy showed the state unchanged. The patient was therefore catheterized twice a day, in the morning and in the evening.

On December 20, the patient left the clinic at his own request.

The patient went to another urological division where the cystostomy was made. Three days after the operation the patient died with symptoms of *uræmia* and of the weakening of the heart.

The post-mortem examination showed:

Status post sectionem altam. Ligamentum interuretericum hypertrophicum. Hypertrophia vesicae urinariae trabecularis. Diverticulum vesicae parietis posterioris lateris dextri (altitudinis 5 centimetr. latitudinis 2 centimetr.) et parietis posterioris lateris sinistri (altid. 0.8 centim., latid. 1.2 centim.). Hydronephrosis ambilateralis. Dilatatio ureterorum ambil. Cystopyelo-nephritis purulenta, chronica, ascendens. Paracystitis

# CHOLANGITIS FOLLOWING CHOLECYSTENTEROSTOMY

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# CONGENITAL HYPERTROPHY OF INTERURETERAL RIDGE

chronica. Peritonitis fibro-purulenta, diffusa recens. Hypertrophica cordis sinistri et dilatatio cordis dextri. Hyperaemia et cedema pulmonum. Degeneratio parenchymatosa hepatis. Tumor lienis et bronchitis muco-purulenta. In Fig. 2 are seen changes which took place in the wall of the bladder, in the ureter and in the kidneys, caused by a long stagnation of urine. The wall of the bladder is trabeculated and hypertrophied, especially the layer of muscles.

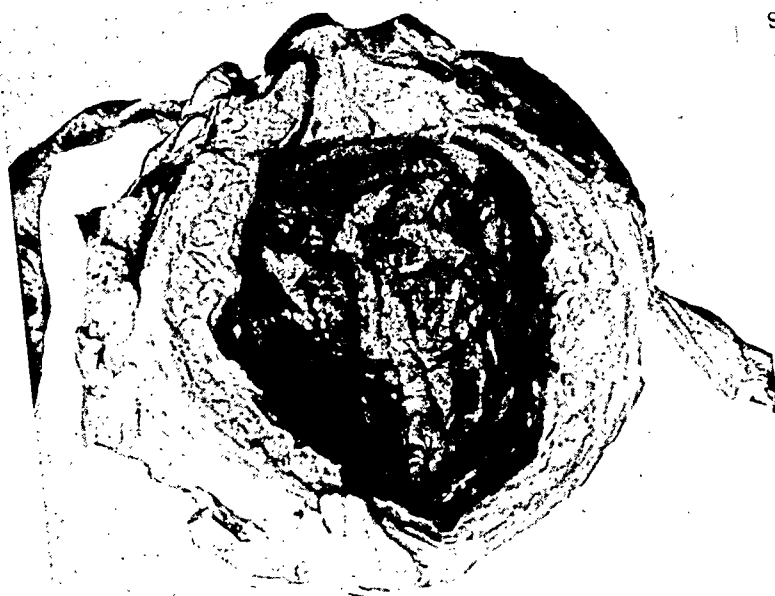


Fig. 2.—Showing the hypertrophied interureteral ridge.

In Fig. 2 are seen changes which took place in the wall of the bladder, in the ureter and in the kidneys, caused by a long stagnation of urine. The wall of the bladder is trabeculated and hypertrophied, especially the layer of muscles.

The hypertrophy of the interureteral ridge was the cause of the complete obstruction to urinating.

This difficulty in urinating caused by the above described hypertrophy of the interureteral ridge increased slowly but steadily every day, and resulted finally in complete obstruction of the bladder.

last the enormous quantity of two litres. Constant presence of residual urine in large quantities caused difficult outflow of the urine from the ureters and renal pelvis, it further caused their considerable dilatation which resulted in the atrophy of the renal parenchyma and in the insufficiency of both kidneys shown by the number of 110 milligrams, as this was the quantity of the nitrogen in 100 centimetres of blood. A comparatively light operation and subsequent slight infection, which spread in the weakened body, brought in a short time the death of the patient exhausted by the long disease.

The above case is, to my knowledge, the first case described in literature of congenital hypertrophy of the interureteral ridge. In a young man of an athletic body constitution who never had gonorrhoea and who felt sick only when the symptoms of a renal insufficiency appeared, an hypertrophy of the interureteral ridge was ascertained by cystoscopy and post-mortem evidence as the only cause of the obstruction of urination.

So considerable pathological changes, so large ambilateral hydronephrosis, and dilatation of the ureters up to the thickness of an intestine could not possibly arise within several months, but many years were necessary to bring about such changes. The patient probably did not empty his bladder ever since his birth. The capacity of the bladder increased more and more. At

the same time, on account of frequent contraction of the musculus trigonalis all efforts to empty the bladder of the residual urine being fruitless, the trigonal muscle underwent continuous hypertrophy, which, in its turn, caused the hypertrophy of the interureteral ridge.

The post-mortem examination of the body did not show any other obstacles either in the vesical neck or in the urethra that could cause urine stagnation.

As may be seen in the photograph, Fig. 2, the prostate and the posterior urethra do not show any changes. Nor was there any paralysis of the bladder, as no changes in the nervous system could be observed either in life or after death. The hypertrophied ridge was the only cause why all efforts of the musculus trigonalis to empty the bladder from residual urine remained without effect.



## HODGKIN'S DISEASE OF BONES \*

BY ALBERT H. MONTGOMERY, M.D.

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THAT curious pathological entity known as Hodgkin's Disease presents many bizarre pictures that arrest attention from the standpoint of clinical diagnosis. Many pathologists regard it as essentially a disorder of the hemolytopoietic system. As such, they have recognized the frequent involvement of the bone marrow in addition to the lymphoid structures of the body. Just how frequently the bones are affected is difficult to state from an examination of the literature, as they are seldom investigated at necropsy. Ziegler<sup>1</sup> says that the bone marrow is involved in from 30 to 40 per cent. of the cases. Symmers<sup>2</sup> thinks that it is affected in every case. In rare instances the bones seem to be involved primarily. Hammer,<sup>3</sup> in discussing a case of probable Hodgkin's Disease, has suggested that the bone may become involved before the lymph glands. Ziegler in his classification speaks of an osteoperiosteal form of Hodgkin's Disease. In such cases the bone lesions may present a clinical picture resembling either an inflammatory or a neoplastic growth or both, and the diagnosis is most difficult. This assumption of a primary bone involvement is frankly indicated in the following case:

C. K., a white Polish boy, nine years of age, was admitted to the Children's Memorial Hospital on February 25, 1925, because of a lump on the right leg and the neck. He had been well up to about a year before admission, when he was struck on his right leg by a dish bowl thrown by another boy. Two nights later he developed severe pain in the injured region. This pain was present only at night upon going to bed and kept him awake for one or two hours. This continued for a month and during this time no lump or other abnormality was noted.

Two months later a lump appeared on the right leg laterally near the knee. This grew rapidly during the next three days and the skin opposite was red to pink. The lump diminished in size, presumably after poultices, but for the next six months before admission it was of a size similar to that noted when child was admitted to hospital. Four weeks before admission the lump in the back of the neck was noted. This also grew rapidly but subsided a little before admission. It was not inflamed or painful. There had been a marked loss of body weight. A similar swelling of the neck in the same location had been present three years before admission, but it lasted only for three or four days and disappeared after poulticing. The family and past history was negative. When examined the first time he was moderately emaciated and anemic. There was a moderate size node under each angle of the jaw. In the back of the neck, mostly on the right side, there was a tumor about the size of a plum, which was deeply seated. There was no evidence of inflammation. The tumor could be moved slightly but seemed to be attached to the spine or base of the skull. Movement of the neck was not restricted and was painless.

An X-ray examination showed a tumor mass involving the spinous process of the

second cervical vertebra. (Fig. 1.) There was a large swelling of the right tibia occupying its middle one-third. It was spindle-shaped and raised about 2 cm. at its highest point. It occupied the inner surface of the bone, the sharp edge of the tibia being uninterrupted. There was no tenderness or signs of inflammation. There was no general enlargement of the lymph-nodes found although nodes were palpated in the neck, axillæ and groin. Temperature, 98.6. Pulse, 80.

*Operation.*—March 20, 1925. Under ether anæsthesia, a cross-bow incision was made



FIG. 1.—Tumor springing from second cervical vertebra spine.

over the cervical region posteriorly. The tumor mass was exposed beneath the neck muscles. It seemed to be encapsulated and could be separated easily except at the spine of the second cervical vertebra from which it was detached with difficulty. Because of excessive bleeding some small portions of the tumor could not be removed from the right side of the neck. The wound was closed in layers with a cigarette drain in the cavity.

Except for some superficial infection, the wound healed satisfactorily and the boy was discharged from the hospital, April 19, 1925.

The tissue removed from the neck appeared to be homogeneous yellow tumor tissue which was very friable and not very vascular. The microscopic report by Doctor Hibbs, the hospital pathologist, was as follows:

Tumor of neck—densely cellular structure, consisting of lymphocytes, endothelial cells, an occasional endothelial giant cell, a few multinucleated cells (Dorothy Reed). The predominant

cell, however, is polymorphonuclear, in huge numbers, many of them fragmented and about equally neutrophilic and eosinophilic. (Fig. 2.) Opinion—eosinophilic lymphogranulomatosis.

The child was readmitted to the hospital on May 25, 1925, about five weeks after his discharge. The tumor mass in the neck had grown again to about the size it was before the operation and the boy complained of considerable pain in his right leg at the site of the swelling.

The röntgenogram of the right tibia (Fig. 3) showed what appeared to be a chronic osteomyelitis. It was decided to explore this bone.

May 29, 1925. Under ether anæsthesia a longitudinal incision was made over the swelling in the right tibia. By chiseling off part of the anterior side of the tibia the

were given as follows: June 30, 1925, 25 mgs. applied in wound 8 hours.

changes. The tumor masses were not giving him any discomfort. Radium treatments again and was almost as big as a lemon. His physical condition otherwise showed no recurrence and was now the size of a fist. The tumor on the right tibia had also grown Four months later he was admitted again. The tumor on the back of his neck had dismissed with a small discharging wound, July 10, 1925.

Five days after this operation radium was inserted into the wound cavity. He was moderate number of Dorothy Reed cells. Blood pigment is abundant. (Hemosiderin.) of endothelial cells, sparse neutrophilic, many of them fragmented, dense focal and diffuse infiltration of leucocytes, there is a moderately profuse infiltration of eosinophilic polymorphonuclear and infiltrated with ramifying cells of adjacent periosteal hyperplasia. In the granulo- removed at this time was as follows:

The report of Dr. W. G. Hibbs on the histological examination of the tumor tissue closed with silkworm gut sutures. exposed in the bottom of the wound. The cavity was packed with iodoform gauze and neck was removed and the wound opened. The eroded spine of the second cervical vertebra was June 26, 1925. Under ether anesthesia the old operation scar on the back of the a second attempt to remove the mass in the back of the neck.

The boy made a good recovery, so a month later it was deemed advisable to make Red blood-cells 4,200,000. estimation was 80 per cent. 2 per cent. The haemoglobin 30 per cent. and transitionals 6 per cent., small mononuclears 6 per cent., large mononuclears 62 per cent., polymorphonuclear 26,000 with a differential of time, showed a leucocytosis of

Blood examination at the involving bone. philic lymphogranulomatosis giant cell. Opinion—eosino- and an occasional endothelial large cells, (Dorothy Reed) cells, a few multinucleated being lymphocytes, endothelial trophiles, the remaining cells moderate infiltration of neu- eosinophilic leucocytes, a ber of polymorphonuclear tissue. There is a huge num- work of sparse new fibrous granuloma containing a net- periosteum, infiltrating adjacent lymph-nodes, and intimately adjacent to a densely cellular

Bone normally canalized, normal content. There is a marked hyperplasia of the examination of sections of the tissue removed from the right tibia was as follows: The wound healed per primam. The report, by Dr. W. G. Hibbs, of the histological tumor tissue removed from the neck. The cavity was then closed over the bone. It was filled with a yellowish tumor mass similar to the narrow cavity was exposed. It was closed over the bone. The cavity was curretted out down to healthy

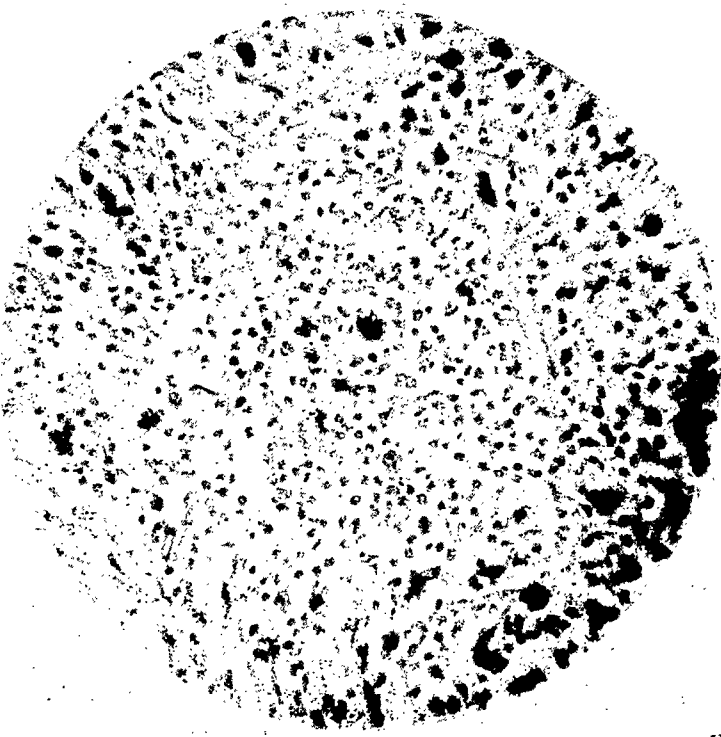


Fig. 2.—Hodgkin's disease of bones.

## HODGKIN'S DISEASE OF BONES

November 5, 1925, 3 Blocks 100 mgs. each, applied over tumor mass in the leg 5 hours.

November 9, 1925, 3 Blocks 100 mgs. each, applied over tumor mass in the leg 4 hours.

November 23, 1925, 2 Blocks 100 mgs. each, applied in cervical region 4 hours.

December 7, 1925, 2 Blocks 150 mgs. each, applied to tumor for 3 hours.

January 5, 1926, 1 Block 250 mgs., applied for 5 hours.

January 19, 1926, 1 Block 100 mgs., applied over tumor mass on neck 4 hours.

March 19, 1926, 2 Blocks 100 mgs., applied over tumor mass on neck 5 hours.

June 3, 1926, 1 Block 150 mgs., applied over tumor mass on neck 5 hours.

June 28, 1926, 2 Blocks 50 mgs., applied over tumor mass on neck 5 hours.

The child was discharged November 12, 1925. He did not return to the hospital until September 9, 1926. He was then weak and emaciated and was having great difficulty in breathing and opening his mouth because of the tumor mass in the back of his neck. This mass was so large that it pushed his head forward, and seemed so heavy that the child held his head with his hand most of the time. The eyes showed marked exophthalmos (Fig. 4); the veins on the forehead were distended. The huge mass on the back of the neck was covered with skin showing the scar of a previous operation. The mass was largest posteriorly and to the right extending forward to the lobes of the ears, measuring 33 cms. at this level. It diminished in size below and anteriorly to the ears, ending in rounded masses which were joined to the main mass but felt almost like discrete glands. The tumor was firm, immovable and not tender, but by its very large size seemed to make movement of the head almost impossible. The greatest circumference of the mass was 55 cms. (Figs. 5 and 6.)

There was a firm, movable, painless mass in each axilla, measuring about 3 by 2 cms. The chest and abdomen showed no abnormalities. The inguinal glands were

palpable but not enlarged. The extremities were very thin. The fingers and toes showed marked clubbing; the distal phalanges were very wide. The right leg showed no evidences of a recurrence of the tumor.

A urine examination showed many red cells and a few pus cells and *B. coli* was found in a culture of the urine. Blood examination showed a hæmoglobin of 70 per cent., red cells 4,350,000 and white cells 65,200, of which 90 per cent. were large polynuclear

FIG. 3.—Showing swelling of right tibia.

# HODGKIN'S DISEASE OF BONES

Cultures of the blood were sterile and blood aspirated from the tumor showed no organisms on culture or direct smear. The blood chemistry was normal and the Wassermann was negative. A large number of X-ray treatments were given to these tumor masses, in addition to the forehead became more distended, the skin showed cyanosis and the eyes and lips were puffed out with edema; dyspnoea was very marked. The tumor mass continued to grow so that by November the circumference of the neck was 70 cms. About the middle of November, he began to complain of pain in the calf of the right leg. An examination showed a tense firm swelling of the calf muscles with some local heat and tenderness. An X-ray plate of the fibula revealed irregularities in the periosteum of the upper half of the bone. The white blood-cells were 52,000, of which 94 per cent. were polymorphonuclears, 4 per cent. large mononuclears and 2 per cent. transitionals. It was thought that the mass in the leg was tumor tissue but because of the rapid appearance, the local signs of inflammation, it was necessary to consider the question of a possible osteomyelitis and an exploratory operation was decided upon.

November 24, 1926. Under local anesthesia an incision was made on the side of the right leg exposing the upper half of the fibula. On separating the muscles from the bone posteriorly a mass of tumor tissue was found attached to the posterior surface of the fibula. The tumor tissue was white, firm and friable, resembling sarcomatous tissue. It was removed as thoroughly as possible and the wound closed.

Sections of the tumor tissue were examined by Dr. W. G. Hibbs, who made the following report:  
Densely cellular granulomatous structure diffusely invaded by ramifying cells of perosteal hyperplasia. Diffuse infiltration of adult and fragmented polymorphonuclear leucocytes, neutrophilic, none if any staining with eosin. Endothelial cells, and so-called Dorothy Reed cells, are abundant. No giant cells are present. Opinion.—Periosteal lymphogranulomatosis. This operation relieved the pain in the boy's leg but his general condition grew steadily worse. Because of difficulty in swallowing and breathing, he took practically no food. An X-ray examination of the chest showed a tumor-like shadow extending from the mediastinum out into the lung. Cyanosis and dyspnoea became more marked and he died December 9, 1926, almost five years after the first clinical symptom of his disease.

*Necropsy Report.*—Generalized eosinophilic lymphogranulomatosis (Hodgkin's Disease); huge suppurative eosinophilic lymphogranuloma of the neck (central liquefaction necrosis), and of the right leg: hyperplasia of the axillary, cervical, peribronchial, peri-



FIG. 4.—Hodgkin's disease of bones.

aortic, peritracheal and inguinal lymph-nodes, slight of the lymphoid tissue of the lining of the bowel; marked emaciation; anemia; tumor compression of the cranial bones; marked œdema of the scalp, eye-lids and loose tissues of the abdomen; hyperemia of the adrenals; cloudy swelling of the kidneys; hyperemia of the brain; œdema of the brain; marked fatty changes of the liver, moderate of the lining of the aorta; slight hyperplasia of the spleen; hypostatic hyperemia and œdema of the lungs; slight right hydrothorax; downward-displaced diaphragm and liver; passive hyperemia of the liver; slight hydro-



FIG. 5.—Hodgkin's disease of bones.



FIG. 6.—Hodgkin's disease of bones.

peritoneum; hyperemia of the lining of the duodenum, bowel and urinary bladder; flexion deformity of the right lower extremity; surgical scars (a) of the right leg (ancient exposure of bone), (b) back of the neck; dirt pigmentation of the lungs and peribronchial lymph-nodes; circumcised penis.

This is the body of a white boy whose actual weight is fifty-eight pounds and measures 146 cm. long. The ribs generally are prominent. The circumference of the upper arms is only 12 cm. and of the forearms 11½ cm. on the right side, and the left forearm measures about 11 cm. in circumference. The upper arm is not quite 12 cm. The finger nails are rounded, pale light purple. There is no change of the palms or soles. There are no palpable superficial lymph-nodes below the neck except that a lymph-node of the right inguinal region about 5 mm. in diameter is palpated from the outside. The right lower extremity is flexed as it lies on the table and cannot be straightened out to an angle greater than 75 degrees approximately. There is a scar beginning 4 cm. below the lower margin of the right patella extending inward to the midline and forward to end in a place in the midline of the right leg approximately 4 cm. above the prominence of the right internal condyle and measures altogether 27 cm. long. The scar generally measures 5 to 15 mm. across as though the bone had been opened into at this place. There is a scar on the outside of the right leg, its upper margin being 9 cm. below the lower margin of the right patella extending down for 7½ cm. It is well healed except

[illegible]

mass. Beneath, small lymph-nodes are found throughout the neck. There is no change of the scalp except œdema. (Fig. 7.)

The calvarium measures 4 to 6 mm. thick generally. The visceral layer of the arachnoid is raised away from the brain by clear fluid. The brain on top is markedly hyperemic. The convolutions generally are rounded. The sulci are 2 to 4 mm. deep. The brain weighs 1160 grams. There is a slight foramen magnum pressure furrow at the base of the cerebellum. Hyperemia is of the entire brain. The lateral ventricle



FIG. 7.—Hodgkin's disease of bones.

walls are collapsed. There is no evidence of new growth in the brain which is put at once into preserving fluid for hardening and later sectioning.

After hardening in the usual brain preservative solution, thin transverse serial sections are made by cutting from front to back. The only changes found are those associated with hyperemia and œdema.

The subcutaneous fat of the midline of the trunk in front is generally only 1 to 2 cm. thick. The skeletal muscles are pale pink to brown. There is a little clear brown fluid in the small pelvis, 75 c.c. in all. The loose tissues of the abdomen are generally wet. The gastro-colic omentum has firm nodules in it that measure 10 by 6 by 6 mm. The spleen is normally free, and weighs 80 grams. The surface is smooth and generally pale purple. When sectioned, the Malpighian corpuscles are a little indistinct. In one place there is a mass 3 mm. in diameter, sharply defined and light gray in contrast to the dark brown and purple splenic pulp.

The bowel generally is hyperemic. The diaphragm on the right side has its upper margin opposite the fifth rib, on the left side the fifth interspace. The lower margin of the liver extends down uniformly 6 cm. below the right costal arch. Its front surface is dark brown to red, smooth and slightly fatty in the left lobe in front. There are no



# CYSTIC LYMPHANGIOMA OF THE GREATER OMENTUM

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AND

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OF THE cystic lymph tumors of the abdominal cavity those of the greater omentum occur least frequently. Wegner's paper in 1874 was the first comprehensive discussion of lymph-vessel tumors. While there is a large literature concerning this class of tumor in general, cystic lymphangioma of the greater omentum has been only briefly discussed, except in the few special papers on the subject.

Spencer-Wells,<sup>1</sup> in 1890, described a large cystic tumor of the omentum in a child. Schwartzenger<sup>2</sup> described a case of recurrent ascites of two years' duration in a child four and one-half years of age. At operation a large solitary cyst, filled with yellow fluid and lined by endothelium, was found hanging from the omentum by several pedicles. Outerbridge<sup>3</sup> while operating on a thirty-four-year-old woman for a uterine fibroid found the greater omentum adherent to the uterus and numerous cysts in the region of attachment. These he interpreted as lymph cysts due to inflammatory occlusion of the lymph vessels. Minervini<sup>4</sup> also described a case of lymphangioma of the abdominal peritoneum and greater omentum which after five years caused death from exhaustion. Stillman<sup>5</sup> removed a cystic tumor of the greater omentum, many of the cysts being as large as 6 cm. in diameter, in a case which he had observed clinically for years. Borchers<sup>6</sup> described a case of progressive enlargement of the abdomen in a four-year-old child caused by a huge cystic tumor of the greater omentum. Kahuschkin's<sup>7</sup> case presented cysts of the omentum, which he interpreted as cystic lymphangioma. At the autopsy of a fifty-year-old man, Henke<sup>8</sup> found a cystic peritoneum and omentum. He diagnosed the condition as lymphangioma but Merkel considered it pseudomyxoma peritonei. Karas<sup>9</sup> found a multicystic tumor of the right half of the omentum at the autopsy of a thirty-eight-year-old woman. He believed that the cysts were embryonal in origin and were developed from misplaced peritoneal cells. Himmelheber and Kirchberg<sup>10</sup> described a case of multiple cysts of the peritoneum in a fifty-one-year-old woman. The cysts were most numerous in the greater omentum, and the lesion was interpreted as either a lymphangioma or a lymphangio-ectasia.

We recently observed a cystic tumor of the greater omentum in a man forty-four years old. His illness dated back for a few months before admission to the hospital on March 29, 1926. The chief complaint during this time was pain in the left lower quadrant of the abdomen and some rather indefinite symptoms referable to the gastrointestinal tract. The physical examination on admission to the hospital was negative except for diffuse tenderness throughout the abdomen, particularly in the lower quadrants. The temperature was 98.4° F. The white blood-cell count was 14,000 with 86 per cent. polymorphonuclear leucocytes, 11 per cent. lymphocytes, 1 per cent. transitionals and 2 per cent. eosinophiles. There were 4,512,000 red blood-cells. The urine examination was negative.

At operation a large cystic mass was found attached to the under surface of the liver and the intestines. This mass was apparently the greater omentum. It was dissected as completely as possible from its attachments. The viscera and the rest of the peritoneum were apparently negative.

*Pathology.*—*Gross.*—The tumor was removed in several pieces. There were two

masses in the liver. The blood-vessels of the mesentery adjacent to the bowel are distinctly engorged. The mesenteric lymph-nodes of the first portion of the small bowel are generally 1 to 2 mm. in diameter, soft and spongy and are oedematous mesentery. The lymph-nodes along the attachment of the large bowel are hyperemic. The small bowel is 565 cm. long. The large bowel is 83 cm. long. There are five areas of ossification of the body of the sternum, three-fourths of which is ossified.

There are few c.c. of fluid in the right pleural cavity and none in the left. The right lung is normally free and generally pink except where mottled with dirt. Near the apex of the right lower lobe the lung is solid in a place  $3\frac{1}{2}$  cm. up and down, 4 side to side about  $3\frac{1}{2}$  deep. Opposite this area the pleura is profoundly hyperemic and dark brown to pink. When sectioned, front to back through this area, a sharply defined granular-like mass is opened into which consists of multiple small lobules generally 1-2 mm. in diameter, similar in all appearances to the tumor at the back of the neck except that it is darker brown than the tumor of the neck. The mass described of this right lung is presumably an increase in size of the lymph-nodes around the larger bronchi with infiltration into the lung, the parenchyma of which is filled with frothy fluid. Sectioning around the bronchi exposes multiple small lymph-nodes with areas in them like the growth of the back of the neck. In the left lung itself there is not evidence of new growths. The left lung is similarly oedematous and blood stained when cut.

When the right lung is sectioned from back to front the lymph-nodes described are at least six in number and make altogether a mass generally 3 by  $2\frac{1}{2}$  by 6 cm. They are smooth and gray when incised. The lymph-nodes of the right axilla weigh 37 grams. The lymph-nodes of the left axilla, with considerable reticulum attached, weigh 13 grams.

The lymph-nodes along the aorta are all prominent, a little more prominent on the left side than on the right. The left adrenal is profoundly hyperemic and weighs 7 grams. The aorta is irregularly stippled with pin-point size yellow plaques. The left kidney weighs  $176\frac{1}{2}$  grams. When sectioned front to back, the parenchyma is swollen. The cortical striations are generally distinct. There is no change of the lining of the pelvis of this kidney. The glomeruli are prominent in reflected light. The liver is particularly firm and free from new growth. The right kidney is not weighed by accident, but is approximately identical in size to the left. It is similarly dark red purple-brown and without evidence of new growth. There is one area that is a little soft and gray. These are put at once into a formalin solution. The left adrenal weighs 5 grams, and is like the left in all essentials. The pancreas is firm and, except for a portion adjacent to the duodenum, weighs 114 grams. When cut across in many places the pancreas is definitely firm, normally lobulated and without other evidence of change.

The apex of the heart consists of left ventricle. There is no change of the lining of the inferior vena cava. There is no change of the lining of the heart or coverings of the valves. The lymph-nodes around the trachea are all prominent. These lymph-nodes are like those described previously except that they contain a good deal of soft coal dust. The liver weighs 1370 grams. The back surface of the liver is like the front. The gall-bladder is normally filled with green bile and the lining is unchanged. When sectioned transversely the central veins and lobular markings are distinct particularly because of the prominence of the central veins. Nowhere is there evidence of new growth. The stomach is normally corrugated and in partial post-mortem digestion. The lining of the duodenum is slightly hyperemic.

The urinary bladder is collapsed. Its lining is particularly rigid and a little hyperemic, otherwise unchanged. The inguinal lymph-nodes extend up to the rim of the small pelvis and along its side. There is no change of the right testicle when it is sectioned, or of the left.

The recent surgical wound of the outside of the right leg is opened and extended. The middle half of the right fibula and tibia are cut out for subsequent study. Just

to the right of the prominence of the tibia near the knee, there is a section resembling a lymph-node adherent to the fascia. When the excised tissue is sectioned back to front there is exposed a mass that is similar in appearance to the tumor on the back of the neck, which presumably is encapsulated. There is no change of the thyroid gland. The swelling under the jaw particularly of the left side is of lymph-nodes which have smooth surfaces and are generally gray. There is no evident change of the mandible. There is no change of the base of the tongue, larynx or trachea. The other long bones are not examined.

*Histology.*—(Paraffin method, H. & E. Stain.) Sections are made of all viscera and are examined especially for changes in the viscera similar to those changes observed in the lymph-nodes. The only changes found anywhere are in the lymph-nodes, or in such structures as are immediately adjacent to lymph-nodes. This includes the spleen, thymus gland, and lymphoid tissue of the lining of the bowel.

Sections of the tumor of the back of the neck are taken in six different places. The structure is diffusely cellular. Cell types are multiple. There are only a few adult lymphocytes. These are replaced by cells that are about twice the size of a lymphocyte. The nucleus is generally pale and in its periphery it contains deeply stained granules that generally extend around the entire periphery of the nucleus with a larger central granule. These are reticulum cells which invade the entire gland mass and obliterate the lymph sinuses. There is a marked proliferation of endothelial cells. The nuclei of these cells occupy three-fourths of the cell. They are generally round and finely granular. Their cytoplasm is clear. Many of these cells have multi-lobed, hyperchromatic nuclei. Plasma cells are abundant.

Throughout these sections there are many endothelial giant cells with "horse-shoe" shape nuclei and a homogeneous cytoplasm. These endothelial giant cells are most abundant adjacent to areas of dense polymorphonuclear neurophilic leucocytes infiltration and necrosis of the surface of the tumor of the back of the neck.

Prominently scattered throughout all sections is a dense infiltration of polymorphonuclear eosinophilic leucocytes. Although these eosinophilic cells are widely distributed, they, like the endothelial giant cells, are most abundant in the areas of suppuration and necrosis, or in the tissues adjacent to these areas. In addition, these eosinophilic polymorphonuclear leucocytes are much more abundantly present in all of the lymph-nodes adjacent to the tumor of the back of the neck, the axillæ and each cervical region, than in the tumor of the back of the neck itself.

The final, uniformly definite feature, is the wide-spread infiltration into all sections of the tumor and lymph-nodes of large, multinucleated cells. The protoplasm of these cells is clear except for scattered irregularly stained shreds. These nuclei generally occupy three-fourths of the total bulk of the cell. Their outline is ragged, and from one to four nuclei are present in a cell. These cells, however, usually have more than one nucleus. These nuclei are rounded, indented and lobed, and lie close together, that is, side by side or in a cluster of three or four to a cell. In each nucleus there is a large nucleolus. The nuclear substance is pale-stained and finely granular. These are the so-called "Dorothy Reed" cells.

Necrotic foci are found only in the tumor of the back of the neck.

(Sections are also made of the adrenals, bowel wall, liver, kidneys, myocardium, spleen, lungs, sciatic nerve and brachial plexus.)

*Note.*—The following observations have been made: viz., (1) The "Dorothy Reed" cells are much more abundant in the post-mortem tissues studied, than in the surgically-removed tissues of six to twelve months before death. (2) There is a definite decrease in the number of eosinophilic polymorphonuclear leucocytes in the post-mortem tissues studied, than in those removed surgically at these periods.

*Bacteriology.*—Culture of the heart's blood, the free abdominal fluid, and of the soft pulp of the tumor of the back of the neck, under aerobic conditions, is negative, after seventy-two hours continuous incubation at 37½ degrees centigrade.

## HODGKIN'S DISEASE OF BONES

*Comment.*—Various bones have been involved in Hodgkin's Disease. In the above case, the second cervical vertebra, the tibia, and fibula were affected. Lesions of the sternum have been reported by During<sup>4</sup> and Lyon<sup>5</sup>; of the skull by Beitzke<sup>6</sup>; of the humerus by Weber<sup>7</sup>; of the femur by Beitzke and Cone<sup>8</sup>; of the clavicle by Burnham<sup>9</sup>; of the ribs by Cone. The vertebrae seem to have been affected more often than other bones. Lesions have been noted by Cone, Burnham, Gibbons,<sup>10</sup> Welch,<sup>11</sup> von Muellern and Grossman,<sup>12</sup> Hauch,<sup>13</sup> Simons,<sup>14</sup> During, Askanazy,<sup>15</sup> Mueller,<sup>16</sup> Weber, Fraenkel and Much.<sup>17</sup> In many cases the periosteum of the posterior part of the bodies of vertebrae have been affected producing pressure on the spinal cord evidenced by symptoms of myelitis. The disease may in this way strongly simulate a tuberculosis of the spine.

The pathological lesion in the bones may be either a granulomatous periostitis, accompanied at times by the formation of osteophytes; or there may be rarefaction of the bone, leading sometimes to pathological fracture. In the bone marrow, yellow or gray nodules may be seen, not sharply demarcated from the red marrow. They consist of fibro-gelatinous material which may go on to cyst formation. Symmers has described three types of changes in the bone marrow.

1. Overgrowth of connective tissue with obliteration of the marrow cavity; (2) histologic changes essentially similar to those in the lymph glands; and (3) extraordinary hyperplastic changes in the marrow cells, especially the myelocytes and non-granular cells of the lymphocyte type.

In relation to the bone involvement, the histopathology shown in the sections taken from the lymph glands and bone marrow in my case is of interest. In addition to the usual bizarre picture of multiple cell types including many Dorothy Reed cells, the sections showed a most marked eosinophilia. While eosinophilia in the tissues is not infrequent at places of low grade infection such as the appendix, Fallopian tubes and the cervix and also at the site of attachment of intestinal worms, it is probably fair to agree with During that although eosinophils are not peculiar to Hodgkin's Disease, there is no other condition in which they are found in such large numbers.

There is, according to Symmers, a general opinion that these eosinophilic cells are derived from the blood. Most of them are polymorphonuclear cells but some are mononuclear. This mononuclear eosinophilic cell is regarded by Symmers as a myelocyte derived from the bone marrow. He believes that the provocative agent of Hodgkin's Disease initiates disturbances in the bone marrow, characterized, among other things, by proliferation of the non-granular mononuclear cells of the lymphocytic type, eosinophils and eosinophilic myelocytes. These cells, together with the myeloplaxes, are thrown into the circulation and filtered out by the lymph-nodes or deposited in them in response to chemotactic attractions, the fibrotic changes in the recipient tissues representing a purely local reactive process. The histologic changes beyond the lymphoid system proper, namely, in the liver, kidneys, etc., represent a reaction on the part of normally existing lymphomatous

foci to the same toxic substance which is responsible for the disturbances in the bone marrow and for the myeloid transformation of the lymph-nodes.

The apparent primary involvement of the bone in my case would seem to support this view of Symmers for lymphatic involvement was not demonstrable until about two and a half years after the onset of the disease. Possibly if more detailed explorations of the bones could be made at necropsy we would find the marrow involved in most instances. At any rate, it would seem advisable in every case of Hodgkin's Disease to make a röntgenological examination of the entire skeleton. This could be supplemented by a biopsy of any suspected areas in the bones. The information thus obtained would add materially to our knowledge of the disease and in certain cases where the bone seems to be involved primarily, it would be a most valuable diagnostic procedure.

In conclusion, from the review of the literature and from the history of the case which I have presented, I wish to point out:

1. That Hodgkin's Disease may exhibit a primary bone involvement simulating a bone tumor or osteomyelitis.

2. That bone involvement, either primary or secondary, is probably more frequent than is generally believed in Hodgkin's Disease.

3. The vertebræ show the most frequent involvement often producing a pressure myelitis simulating Pott's Disease.

4. That marked eosinophilia in the tissue sections in Hodgkin's Disease points to an essential irritation and involvement of the bone marrow in this disease and should lead to a careful examination of the osseous system in such cases.

Grateful acknowledgment is made for the free use of the excellent monograph of J. P. Simonds, *Archives of Pathology and Laboratory Medicine*, vol. i, p. 394, March, 1926, which contains an extensive bibliography.

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# PUERPERAL GANGRENE OF THE EXTREMITIES

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AND  
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PUERPERAL gangrene of the extremities is seldom observed, even in large general hospitals. The rarity of the condition is rather surprising, for it has its origin in infection, and puerperal infection, unfortunately, is still far from uncommon. Stein, in 1916,<sup>1</sup> could collect only sixty-two instances of this complication occurring after delivery at full term, and three following abortion. To this list he added two other cases coming under his personal observation. In one of his patients the gangrene followed a mid-forceps delivery at term; in the other patient it developed subsequent to a curettage performed on the seventh day after a septic abortion at three months. In 1925,<sup>2</sup> Stein again reviewed the subject, adding cases reported by Rice<sup>3</sup> (two observations), Penkert,<sup>4</sup> Chesky,<sup>5</sup> Key,<sup>6</sup> and Knipe.<sup>7</sup> Besides these, we have found in the literature two other recent cases not included in Stein's lists, which were reported by Hicks<sup>8</sup> and Entwistle.<sup>9</sup> Of these eight additional cases, six followed delivery at term and in two instances (Knipe, Key), the gangrene developed after abortion. Thus we have a total of sixty-nine instances of gangrene of the extremities following delivery at or near term, and six subsequent to abortion. Stein included in his reports nine cases of peripheral gangrene following gynecological operations and four developing during pregnancy, but we will not touch upon these in this discussion.

In view of the fact that this condition is so infrequently encountered, we feel that the report of an additional case will be of interest. It might be well to note that in our patient dry gangrene of both legs and thighs, in their entirety, was present. We have not found, in the articles above cited, a description of a similar case with such extensive involvement. In only one of the abstracts in Stein's first paper (Phillip's case), is involvement of the thighs mentioned.

Mrs. H., aged thirty-seven, mother of ten children, was admitted to the Charity Hospital of New Orleans, La., January 26, 1926. She had been delivered normally at home, several miles from the city, January 2, 1926. She remained in bed for ten days. The history obtained did not elicit any evidence of fever during this time; it is possible, of course, that a mild, unrecognized pyrexia may have been present. Soon after she resumed activity, pain developed in both legs, and the legs and feet became numb. She was again confined to bed. The right foot and the lower third of the right leg turned purple, and dry gangrene developed. She was brought to the hospital fourteen days after this condition began to manifest itself.

On admission, the right foot and the right leg up to the knee showed the typical appearance of dry gangrene. The extremity was cold, there was no pulsation in the dorsalis pedis artery, and the skin was dry, brownish, and leathery. The skin of the right thigh and of the left foot, leg, and thigh presented a mottled appearance, some areas being purplish, while others were practically normal to sight and touch. Vaginal examination showed that the uterus was fairly well involuted, the adnexa were appar-

ently normal, and no inflammatory exudate, tenderness, or other abnormality could be detected. The patient's general condition was surprisingly good. The temperature was 100 degrees, the pulse was 120, the respirations 28. The heart and lungs were negative, the abdomen was soft and not distended, and the abdominal organs presented no abnormality. The urine contained some albumen and some red blood-cells. No blood count was made, and no blood culture was taken. It might be noted that the highest temperature was 101 degrees; this was on January 28 and 29.

A few hours after admission, amputation through the middle of the right thigh was performed under ether (M. O. M.). She was in good condition during the operation, and reacted satisfactorily. Two days later (January 28), the left foot, leg and thigh also had become definitely gangrenous, and amputation was performed at the upper third of the left thigh. The gangrene progressed on both sides, and, as a forlorn hope, on the morning of January 30, the left thigh was disarticulated at the hip, and the right thigh was reamputated near the hip-joint. She died on the table just as these operations were being completed, with the symptoms of pulmonary embolism.

Autopsy was performed a half hour after death by Dr. G. H. Hauser. The following notes are taken from the protocol.

Only a partial autopsy was allowed, with examination of the organs *in situ*. Both lungs examined *in situ* were collapsed and devoid of air. Sections into them showed numerous deep purple areas of infarction. The pulmonary artery contained an antemortem clot at the bifurcation. In the peritoneal cavity no pathological lesions were found. The uterus was slightly larger than normal and of firm consistency. The adnexa showed nothing of note. Section of the uterus *in situ* showed thickening of the myometrium with fatty degeneration present. The endometrium was thickened and the vessels of both the endometrium and the myometrium showed thrombosis. Section of the uterine vessels near the cervix disclosed thrombosis of the arteries; the veins were empty. The aorta was opened, and in the lower abdominal portion of the vessel there was found a thrombus extending from a point  $1\frac{1}{2}$  cm. above the bifurcation down into both iliac vessels and their branches, including the uterine arteries. The iliac veins contained some loose thrombi extending into the inferior vena cava. The arterial thrombus was adherent to the intima, which, after removal of the thrombus, was seen to be roughened and to have lost its normal smooth, glistening appearance. Cultures from this thrombus grew a diplo-streptococcus. Unfortunately, the cultures were discarded by a laboratory attendant before a complete bacteriological study was made. We feel that this organism is apparently similar to the one described by Rosenow in a recent communication<sup>30</sup>; this streptococcus was isolated by him from five cases of post-operative pulmonary embolism and one case of portal thrombosis. He also found it in all except two of twenty-five other cases, it being isolated from a thrombus, an embolus, or an area of infarction. This organism was found by him to be a Gram-positive diplo-streptococcus, of low general virulence. These characteristics may account for the mild febrile reaction and the lack of constitutional symptoms observed in the cases reported by him, as well as in the patient under consideration. Experimentally, Rosenow found that intravenous injection of pure cultures of this organism in lower animals produced thrombosis and embolism (especially pulmonary), but other lesions were rarely found. Factors such as anæsthesia, operative procedures, slowed circulation, and traumatism of the blood-vessels, which are considered to be of etiologic importance in the development of thrombosis in man, appeared to favor the clot formation in these experimental animals, but in some instances mere injection of the organism sufficed. It was found that nine of these animals developed immunity ten days to two weeks after the injections were completed, and that subsequent injection of the cultures failed to produce thrombosis.

It may be noted that few autopsies are mentioned in the records of the cases collected from the literature. In the patients coming to necropsy, extensive vascular obstruction was noted in most instances, generally involv-

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ing the aorta and its branches (Borié and Du Casel, Bennet, Duncan, Mair), rarely the vena cava and its branches (Knipe), and still more infrequently both sets of vessels (Lancereaux). Vegetations on the heart valves were recorded in five instances.

A classification of the seventy-six cases according to the part affected (considering the chief lesion noted) gives us the following distribution: Lower extremity, one or both (the latter in sixteen cases), after delivery at term, 60; lower extremity, one or both, after abortion, 5; upper extremity, after delivery at term, 10; upper extremity, after abortion, 1. In some instances, multiple lesions were present. Thus, Bigg's case and one of Maurice Reynaud's cases had gangrene of both hands, both feet, the tip of the nose, and portions of the ears. Rowe's first case had gangrene of both legs, five fingers, and the right ear. In McFarlane's patient the right leg and the right arm were involved. In another instance there was symmetrical gangrene of fingers, toes, and ears.

Considering the type of delivery, we find that of the seventy patients at term, nine were delivered instrumentally or had long, tedious labors, in two other instances the placenta was removed manually, and in twenty-nine cases the labor was recorded as normal; in the records of the remaining thirty the details of the delivery were not given. Of the six cases following abortion, the details are lacking in three instances; two of the abortions were septic (one was self-induced with a hatpin), and in the sixth (Key's) the gangrene followed therapeutic abortion at the fifth month. In this case, embolectomy of the common femoral artery two hours after the onset of symptoms was followed the next day by a similar operation on the popliteal artery, but gangrene developed five days later, and amputation of the thigh was necessary. The patient recovered.

The time of appearance of the gangrene is variable; it usually develops one to three weeks after delivery. In Fussell's case it was noted two hours after the completion of the labor, but in this instance the thrombus must have formed during the last few days of the pregnancy. In Bigg's patient six weeks elapsed. In Rouse's second case there was an interval of three and one-half months. It is doubtful in this instance that the gangrene was really of puerperal origin.

Various intercurrent infections are noted in the case reports, *e.g.*, typhoid fever, pneumonia, and pleurisy. General sepsis is recorded as a complication three times, pyemia once, and acute suppurative peritonitis once. Two patients also suffered from puerperal mania. It is interesting to note that in six instances the patients were eclamptics. It is possible that the well-known tendency to rapid coagulation of the blood which is a characteristic of eclamptic patients may cause such patients to be especially susceptible to thrombosis in the presence of the infection which is the main factor. Multiple small thromboses, as is well known, are found at autopsy in most fatal cases of eclampsia.

*Etiology.*—It appears that infection is always responsible for this formidable



able complication. Note that in the case here reported diplo-streptococci were found in the thrombus. In some instances, as in our patient, it is clear that the infection spread from the uterine sinuses by way of the uterine and iliac arteries to the aorta. In other cases (*c.g.*, the one reported by Entwistle), the thrombosis appeared to be due to an embolus from the infected heart valves of a septic endocarditis. Stein inclines to the view that this group is the larger. In three cases a persistently patent foramen ovale was thought to be concerned in the etiology of the condition. Also, according to Stein,<sup>1</sup> the toxins of the offending bacteria "play an important part, probably through lesions of the vascular endothelium, which in combination with the altered condition of the blood during the puerperium predisposes to the formation of thrombi." This observation is in accord with the findings of Rosenow in his experimental work with the organism isolated by him, but these findings also point rather strongly toward an elective localization on the part of these streptococci.

*Diagnosis.*—Pain in the affected extremity is a constant finding, and is usually quite severe. Hence its occurrence in a woman manifesting the usual signs and symptoms of puerperal infection should lead us to study carefully the circulation of the limb. Absence of pulsation of the arteries is of course noted below the obstruction in cases of arterial thrombosis. In venous obstruction, the inflamed pelvic veins may be felt by rectal or vaginal examination. The temperature of the limb is lowered, and a livid, frequently mottled, discoloration develops. Arterial obstruction is the more frequent type, is usually sudden in onset, and occurs early in the puerperium. Venous blocking may be sudden or gradual, and tends to appear later than the arterial form. Stein reminds us that phlegmasia alba dolens rarely terminates in gangrene. Early diagnosis is essential if embolectomy is to be attempted, as this operation is of value only if performed within the first twenty-four hours after the development of the obstruction.

*Prognosis.*—The outlook is extremely grave. Forty of the seventy-six cases of this series died, including three of the six developing after abortion. Only four of the thirty-six patients who recovered were cured without operation (generally amputation). The prognosis is more gloomy because of the fact that the general condition of the patient is as a rule very unsatisfactory. However, Stein, in his second paper, states that the mortality rate has been cut in half by modern methods of treatment.

*Treatment.*—General supportive measures are indicated. In recent years, embolectomy has been employed in suitable cases. Key collected reports of thirty-six such operations in various types of vascular obstruction which were performed within the first twenty-four hours, with sixteen favorable results, including two cases with the thrombus at the aortic bifurcation. Of Key's ten personal cases, only four developed gangrene after the operation. Early intervention is essential, preferably within the first few hours, certainly within the first twenty-four hours. Buerger (quoted by Stein) states that the operation is successful only when the arterial wall is still undamaged, and

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secondary thrombosis has not yet occurred. Professor Rudolph Matas, in discussing our case with one of us (E. L. K.) shortly after the patient's admission, predicted the finding of a thrombus at the aortic bifurcation, and called our attention to this work of Key. However, it appeared that a favorable outcome was not to be anticipated after an embolectomy in this instance, and this opinion was substantiated by the autopsy findings. Vignes<sup>10</sup> also suggests that, if arterial obstruction is diagnosed early, before or shortly after the development of gangrene, one may attempt to reestablish the permeability of the artery. If gangrene has already manifested itself, and the line of demarcation has been established, amputation well above this line, according to accepted surgical principles, is indicated. As noted above, most of the cures in this series followed amputation. But as the thrombus is usually located some distance above the line of demarcation in these cases, it follows that the amputation must be high in order to be successful.

*Note.*—In a case recently cared for by the reporter (E. L. K.) superficial blebs and small areas of discoloration on the skin of the affected leg led to the tentative diagnosis of developing gangrene of the venous type. The patient was suffering from a severe septicemia following a criminal abortion, and died about twenty-four hours after these points were noted. As a definite diagnosis was not established, this case was not included in the series here presented.

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## MORRIS JOSEPH

The following day, September 7, his condition was grave, the temperature was 103.8° F., pulse 160, hardly palpable, respirations 32. The patient was in extreme shock. A bronzing of the entire upper leg was present with definite crepitation of the subcutaneous tissues, a large amount of thin foul-smelling pus was exuding from the wound. He was again taken to the operating room. Free longitudinal incisions were made in the thigh down through the fascia, which appeared healthy.

X-ray examination showed multiple comminuted fractures of the pelvis. Cultures taken from the wound and inoculated into a rabbit produced gas gangrene in a few hours and the bacillus *Welchii* was recovered from the peritoneal cavity. It likewise appeared in the anaërobic media the following day. Mulford's perfringens serum, 100 c.c. was promptly given and this dose repeated the following morning.

The change in the patient's condition was amazing, even after the first intravenous injection of the serum. The temperature came down promptly, but the pulse was the striking thing. It could be counted with ease and the rate was 120. The patient continued to run some temperature until the eighteenth day, but showed a very steady improvement until the day of his discharge, November 24, 1927, about twelve weeks after admission. He has now practically entirely recovered, is up and about and the röntgenogram shows the pelvis entirely healed, except for some separation in the fracture of the right pubis.

## CYSTIC LYMPHANGIOMA OF THE GREATER OMENTUM

large cystic masses, one measuring 6 by 7 by 2 cm.; the other mass was irregular and measured 9 by 8 cm. and up to 3 cm. in thickness. In addition there were several pieces of rather nodular, firm and fatty omentum, and several smaller multicystic masses which had evidently been removed separately but which undoubtedly had been connected with the main tumor tissue.

The smaller of the two main tumor masses was very cystic, and only a small amount



FIG. 1.—Showing most of the tumor mass with several of the larger and smaller cysts exposed.

of fat remained on one surface which enabled one to identify it as greater omentum. When this tumor was sectioned liberally, it was found to consist of hundreds of single and communicating cysts which measured from 1 mm. to 2 cm. in diameter. The cyst wall linings were smooth and the walls for the most part were less than 1 mm. thick. The cysts were filled with a thick jelly-like material. In the more solid portions of the tissue many tiny spaces were seen which on pressure oozed fluid and gave the gross impression of a soft lymphangiomatous tumor so often seen in the skin.

# THE TECHNIC OF BLOOD TRANSFUSION \*

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BLOOD transfusion is a powerful lifesaving measure of proved efficacy, when used in the presence of definite indications. Improvements in technic and increased knowledge of physiologic chemistry have widened the indications considerably during the past few years.

There is no means of estimating the number of transfusions done in the United States, but in the larger hospitals, it is almost a daily procedure. Geoffrey Keynes<sup>1</sup> says, that in the London hospitals, there were 428 transfusions in 1925, and that, up to November, 1926, over 700 had been done.

The indirect or sodium citrate method is the one most generally practiced at present. There are a great many technics, all of which are more or less satisfactory, but it seems to me that the simple way is the most practicable. I experienced great technical difficulty and waste of time and temper, till I adopted the technic, I shall now describe. (See Fig. 1.)

*The technic* consists in the use of a Potain aspirator to draw the blood into a graduated bottle, in which there is a vacuum. This bottle should contain 50 c.c. of 2 per cent. sodium citrate solution for each 500 c.c. of blood to be withdrawn. The citrate is first allowed to run into the bottle through the needle and tubing used to collect the blood. The bottle receiving the blood is placed in an irrigator can which contains water at a temperature of 100 degrees Fahrenheit, to maintain the blood at an even temperature. The bottle should be turned back and forth occasionally to diffuse the citrate and prevent coagulation.

When the desired amount of blood is obtained, it is strained through gauze to remove possible clots, and introduced into the recipient's vein by gravity, from a glass cylinder. Normal salt solution proceeds and follows the introduction of the blood. Positive pressure can be put on the column of blood in the cylinder by means of a bulb pump attached to a glass tube passing through a rubber cork which fits the cylinder. This will increase the rate of flow over that by gravity, but it is rarely necessary, and is of doubtful propriety.

One can take 600 c.c. of blood from the donor's vein in five minutes, if the needle is squarely in the vein and there is a strong vacuum in the bottle. Should the stream of blood running into the bottle slacken, it may be that the tourniquet is too tight, the needle may be displaced, or the blood may be becoming more viscous and preparing to clot in the needle. More com-

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\* Read before the Honolulu County Medical Society, November 4, 1927. "Published with permission of the Surgeon General, who is not responsible for any opinion expressed or conclusion reached herein."

monly, the trouble is a decreasing vacuum due to leaky connections, and increasing the vacuum brings back a free flow of blood. The air can be pumped out of the receiving bottle without interrupting the flow of blood from the vein. (See Fig. 2.)

This technic first suggested itself to me after reading the report of Davis and Cushing<sup>2</sup> on blood replacement in intracranial operations. This was a method of salvaging the patient's own blood by aspirating it from the field of operation through a glass tube connected by a rubber tube with a collecting

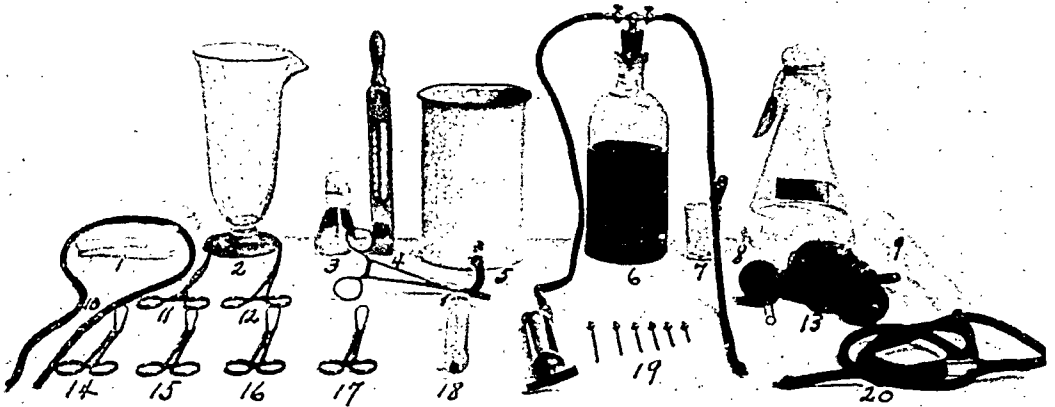


FIG. 1.—Apparatus and instruments used in blood transfusion, indirect, sodium citrate method. 1, Gauze sponges, 4x4 in. 2, Graduate glass, 600 c.c. 3, Sodium citrate, 2 per cent., in 100 c.c. flask. 4, Thermometer, bath. 5, Can, irrigator, white enamel. 6, Bottle, glass, capacity, 1, litre, graduated, with Potain aspirating cork, tubing and metal pump. 7, Medicine glass and dropper. 8, Normal salt solution, in 1000 c.c. flask. 9, Glass cylinder, graduated, 300 c.c. 10, Tourniquet. 11 and 12, Kelly artery clamps. 13, Rubber stopper, fitting glass cylinder, with right angle glass tube passing through, to outer end of which, is attached Paquelin cautery bulb, to obtain positive pressure. 14, 15, 16 and 17, Towel clips. 18, Syringe, glass, Luer, 30 c.c. 19, Needles, transfusion, gauge, 12-15, assorted lengths. 20, Tubing, connecting. Tripler U. S. Army General Hospital, Honolulu, Territory of Hawaii.

flask, which is continuously evacuated of part of its air by means of a water pump.

Hahn<sup>3</sup> modified this method in some of the details and used a Brophy suction apparatus to create the vacuum in the collecting bottle. McGrath,<sup>4</sup> in 1914, had previously made use of the aspiration principle in transfusion, and several modifications of its application have been published. So that I hasten to say that this technic is not entirely original with me, for it is essentially the same as used by Keynes, and published by Dr. E. L. Spriggs,<sup>5</sup> of Ruthin Castle, in the *British Medical Journal* of November 27, 1926.

I have modified the Spriggs technic in some details which I think are important, particularly, in changing the amount and strength of citrate solution used per 500 c.c. of blood, from 100 c.c. of 4 per cent. to 50 c.c. of 2 per cent. Again, I use a tube-tourniquet instead of the sphygmomanometer cuff, as the tube can be sterilized, and is more easily handled otherwise. I prefer the irrigator can to a jug, to contain the hot water, as an irrigator can with a short rubber tube can be easily drained of its water, and fresh hot water added to get the required heat. I always strain the citrated blood for possible

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clots. Keynes introduces the blood from the same container into which it is received, by using positive pressure and a tube passing to the bottom of the container. It seems to me that a slower rate of flow, *i.e.*, by gravity, is preferable, and less open to other objections.

So far as I have been able to judge, there is but one objection to this method, and it is the result of faulty technic. The criticism is, that clotting of the blood is more apt to occur in its passage through the tubing and Potain aspirator cork, than when the blood is drawn by the simple introduction of a needle or trocar; further, that if clotting does occur, it will be necessary to

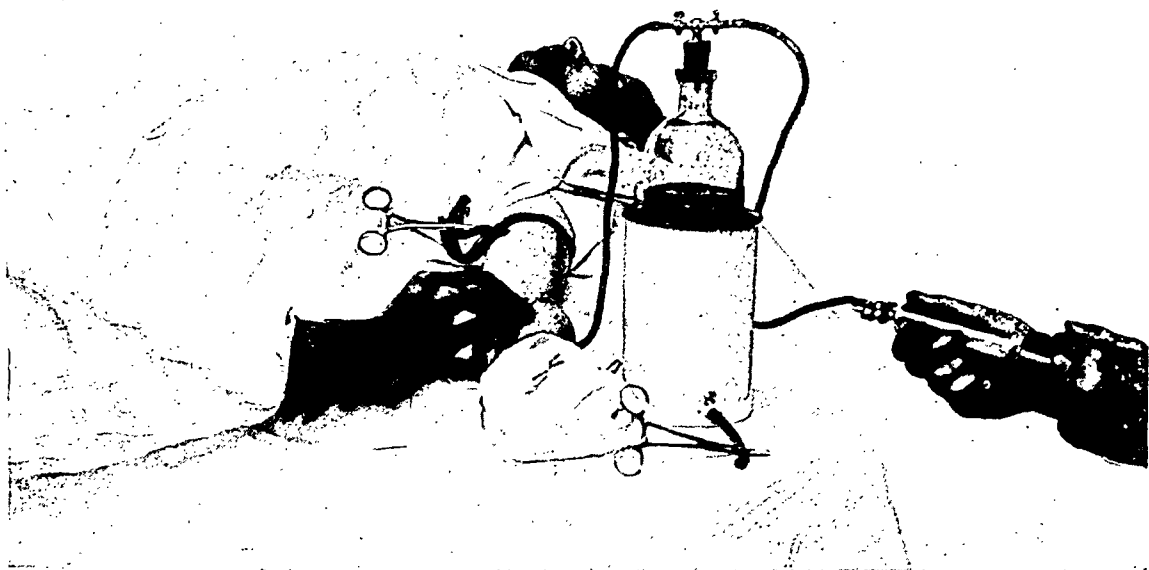


FIG. 2.—Withdrawal of blood for transfusion by the indirect sodium citrate method, showing apparatus and draping of patient. The stream of blood passing into the bottle can be regulated at will by increasing or decreasing the vacuum, without interrupting the procedure. Tripler U. S. Army Hospital, Honolulu, Territory of Hawaii.

discard the apparatus, as it is very difficult to remove the clots from the tubing and cork.

In the first place, the aspirator should not be connected to the needle until a free flow of blood from the needle is obtained which shows that the needle has been introduced into the vein correctly. When the aspirator is connected to a needle squarely in the blood stream, a free uninterrupted flow of blood is certain, so long as there is a vacuum in the bottle. Clotting in the apparatus, under these circumstances, is impossible. If, however, the needle becomes misplaced, or is not made to enter the vein completely in the beginning, clotting is very apt to occur in the cork, or anywhere along the course of the flow. To provide for this contingency, it is well to have at hand several needles, and an extra aspirating cork with tubing.

With this technic, I have many times, with but one assistant, transfused a patient within twenty minutes, counting the time taken in withdrawal of blood from the donor. It seems unnecessary to state that the time element is an important one in most conditions calling for transfusion. I have used the same apparatus and transfused salvaged blood from the same patient. The

blood is received into a closed container, and though this may be negligible, there is certainly less opportunity for chance contamination. Another advantage is, that if demanded, the procedure can be carried out by one sterile operator and one non-sterile assistant. But the most desirable feature of this technic from my viewpoint, is the ease with which it can be performed. There is not the strain of holding the needle so as to direct the flow of blood into a container; nor changing position of arm and container as the blood stream slackens or augments; nor the tedious drop by drop addition of citrate, and the constant stirring; nor many other annoying details, unnecessary to mention.

Finally, with this technic, one clean puncture of the donor's vein is sufficient, while with other technics, it is frequently necessary to stick a vein several times. In view of the difficulty sometimes experienced in securing donors, this consideration is of importance. I recommend this technic as a quick, easy, certain, and efficient technic for blood transfusion.

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# TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD JANUARY 16, 1928

The President, DR. CHARLES F. MITCHELL, in the Chair

CALVIN M. SMYTH, JR., M.D., RECORDER

## REMOVAL OF BRAIN TUMORS

DR. FRANCIS C. GRANT presented two patients from the neuro-surgical clinic of Dr. Charles H. Frazier.

These patients were presented to emphasize the good results which may be obtained following accurate localization and complete extirpation of certain types of these lesions. Encapsulated brain tumors arising from the cerebral envelopes, the meningiomata, present two chief difficulties to the neurosurgeon: first, an exact determination of the position of the neoplasm from clinical and other evidence, which, as will be seen from a consideration of the following case histories, may be extremely meagre; secondly, proper access to the growth and the control of hemorrhage during its removal.

To properly localize the growth requires a detailed history, the closest search for positive neurological symptoms by the varied means at our disposal, X-ray studies, and finally recourse may often be necessary to ventricular estimation or ventriculography. Whether or not a proper exposure of the tumor can be obtained depends to some extent upon its position, although there are few areas on the surface of the brain which cannot be explored. The degree of hemorrhage encountered varies with the vascularity of the growth, its position and the degree of obstruction it has produced in neighboring blood-vessels. Control of hemorrhage depends upon the skill and preparedness of the individual operator and his experience in handling such problems. Multiple operations may be necessary to remove a very vascular meningioma, progressing a little farther at each attempt until complete removal without too severe hemorrhage has been accomplished. Fresh muscle, silver clips, hot wet cotton tampons, bone-wax, a suction apparatus, and patience will go far in carrying through successfully the extirpation of even very vascular tumors. And if a meningioma is completely extirpated along with its dural attachment, the patient can be assured that no recurrence will occur.

CASE I.—*Extirpation of a large right frontal meningioma arising from the falx at the longitudinal sinus and involving the dura over the superior surface of the frontal cortex. Operative recovery.* M. L., a barber, forty-two years of age, white, was referred to the University Hospital on June 23, 1925, by Dr. Clarence Patten. His chief complaint was failing vision. A year previously he first noted failing vision. Ten weeks ago he found he could no longer read. Since that time his vision has continued to decrease

progressively until at present he has barely light perception. There has never been any headache, vomiting, dizziness, or motor or sensory loss noted. He does not believe that his senses of hearing, taste or smell have been in any way disturbed. There have been no dispositional changes. His past medical, family, and social history are unessential. The important points in his neurological examination were slight weakness of left face and hand, a bitemporal hemianopsia with a choking of three diopters in the right eye and two diopters in the left. X-ray studies showed a localized thickening of the frontal bones

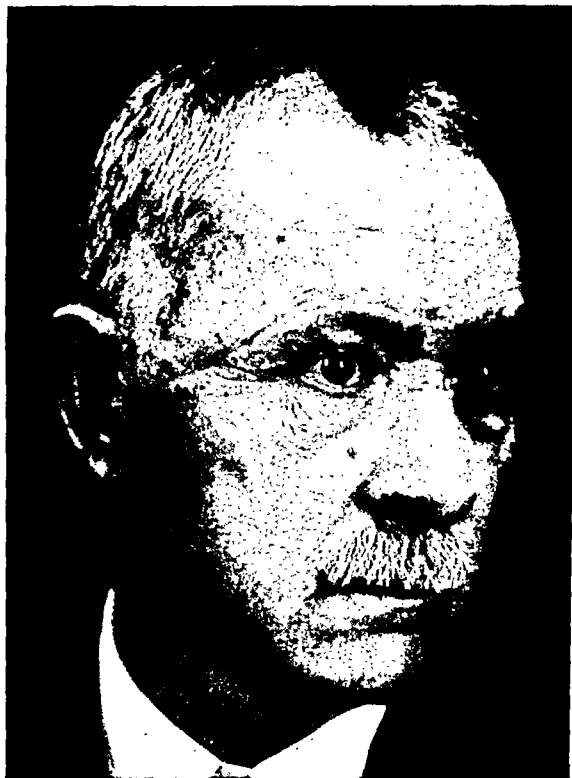


FIG. 1.—Photograph of patient Case I, showing scar.

in the midline, with destruction of the outlines of the sella and the clinoid processes. *Diagnosis.*—Right frontal meningioma arising from the falx low down in front and pressing upon the optic chiasm and sella regions from above.

*Operation.*—Doctor Grant on July 1, 1925, performed a right transfrontal craniotomy under local anæsthesia. Free bleeding occurred from the midline incision. The bone at about the hairline was thick and vascular, corresponding with the X-ray findings. The hemorrhage was controlled with bone-wax and hot wet tampons. Except for this bleeding the flap was reflected without particular difficulty. A steady continuous ooze was encountered from the dura near the midline. To combat this a section of muscle had been removed from the patient's leg. Placing a flat graft of muscle over the bleeding area and sucking a wet cotton compress down over it, plus light

compression from an assistant's fingers, controlled this bleeding. On reflecting the dura from below upward, the edge of a large encapsulated nodular growth came into view. By cutting the dura close around its lateral margin its outline could readily be determined. The dura in the lower part of the flap was left intact to protect the cortex during the manipulations necessary to remove the tumor. Many large veins running from the cortex to the tumor were doubly clipped and sectioned. Light pressure with cotton tampons over the brain showed that the growth had been freed from its lateral cortical attachments and could be tilted inward toward the midline. By working inside the pial covering of the tumor it was possible to brush from its surface a number of large vessels which were holding it in place. Several fine sutures were now passed through the lateral dural edge of the tumor and by gentle traction on these threads, plus light pressure on the brain, it was possible to tilt the growth upward and inward toward the midline with little or no hemorrhage. A large wet cotton tampon was placed in the tumor bed. The most difficult part of the extirpation was now commenced; namely, the freeing of the growth from its attachment to the falx. By working carefully from either side and clipping and cutting the vessels running from the sinus and finally the

## REMOVAL OF BRAIN TUMORS

sinus itself this was finally accomplished. A section of the sinus and a small area of the falx from which the tumor sprang were removed and the growth and its meningeal attachments lifted out. A muscle graft was placed in the tumor bed against the falx, covered with cotton and sucked down solidly against this area. After complete toilet of the outlying wound the cotton and graft was removed. Pressure over the jugulars to raise intracranial tension and reveal bleeding points produced no bleeding and showed that the hæmostasis was complete. But a thin muscle graft was left as a precaution over the sinus area. The dura was closed up to the section removed, the bone flap replaced, and the wound sutured. The patient was entirely conscious and coöperative throughout this procedure. His post-operative condition was good; his recovery uneventful. At present with proper glasses he can read the newspaper and is without symptoms. [Fig. 1.]



FIG. 2.—Photograph of tumor removed from Case I.

### *Pathological Report*

by Dr. Albert Bothe.—The tumor is 6.5 x 6.5 x 5 cm. in size and weighs 175 grams. Grossly it is encapsulated, nodular, firm, and attached to the dura and falx. Microscopically it shows the typical structure and cell type of a meningioma. [Fig. 2.]

CASE II.—*Ventricular estimation followed by right fronto-temporal bone flap, revealing a meningioma arising from the dura in this region. Extirpation of tumor. Recovery.* A. F., a white chauffeur, aged twenty-seven, was referred to the University Hospital on November 27, 1926, by Dr. Samuel Leopold and studied first on the Neurological Service of Dr. William G. Spiller. His chief complaint was failing vision. About eight weeks ago he noticed occipital headaches and failing vision. These headaches came on in the middle of the day, and lasted about two hours. They occurred at intervals of from three to five days with increasing frequency and longer duration until now they are continuous. At the same time his vision began to fail. At present he can read only coarse print. He states that he can see better out of the right side of his eyes. He believes that his memory has been failing for the past year or two. He has had especial difficulty in remembering and grasping the meaning of written matter. There has been a tendency to fall asleep easily. Past medical, family, and social history unessential.

*Neurological Examination.*—On the first examination the essential features were suboccipital tenderness and headache, suggestively cerebellar gait, ataxia with the left hand in the finger to nose test and coarse tremor in the movements of this hand. No pathological reflexes. A choked disc of four diopters in each eye with concentric contraction of the visual fields was recorded. X-ray studies were negative. An immediate ventriculogram was suggested, but Doctor Spiller thought that he should be kept under further observation. Dehydration by magnesium sulphate was instituted to relieve the pressure upon the optic nerves. After two weeks the following additional

symptoms made their appearance. The headache localized definitely over the right ear, weakness in the left face and hand developed and the memory defect became more pronounced. Impression: Right frontal lobe tumor

*Operation.*—November 29, 1926, Doctor Grant. As the operator was not entirely convinced that the symptoms could not be due to a cerebellar lesion, it was determined to carry through a ventricular estimation before reflecting a right temporo-frontal flap. Accordingly under local anæsthesia a midline

incision which could be used later in forming such a flap was made. It was impossible to reach either ventricle. Since an internal hydrocephalus did not exist, the presence of a cerebellar tumor seemed highly improbable. The right fronto-temporal flap was, therefore, reflected without difficulty other than rather severe bleeding from the bone in the midline anteriorly. On raising the flap the dura was tight and tense with two or three points of furious bleeding in the upper anterior area of the incision. These were controlled with muscle grafts taken from the patient's leg. The dura was then opened and the edge of a vascular well-encapsulated tumor lying just in front of the Rolandic vein in the upper antero-median part of the wound was exposed.



FIG. 3.—Photograph post-operatively of patient Case II.

By careful clipping of vessels running from the cortex to the tumor it was possible to completely free that part of the dura to which the tumor was attached and to sever all vascular connections between the tumor and the cortex. Fortunately the tumor arose from the dura involving the flax so that it was not necessary to ligate the sinus. By making gentle pressure with cotton tampons against the brain about the edge of the tumor, and by brushing off the pia and its vessels from the tumor it was possible to commence its enucleation with very little bleeding. However, since the anæsthetist reported a marked fall in blood pressure he was given an immediate transfusion of 500 c.c. of blood. In the meantime having passed traction sutures through the tumor, gentle tension on them plus light pressure on the brain was continued and the delivery of the mass slowly completed. Several blood-vessels running from the depths of the brain to the tumor required clipping but the growth was finally freed and lifted from its bed without difficulty. A little sharp bleeding accompanied its final removal which was controlled by muscle and cotton placed in the cavity and sucked tight against the bleeding points. Following the transfusion the patient's condition greatly improved. After toilet of the wound, the cotton and muscle were removed from the tumor bed and two small bleeding points picked up in the sucker nozzle and clipped. This completed the hæmostasis in the cavity. Pressure over the jugulars by the anæsthetist caused no further bleeding. The tumor bed was filled with salt solution, and the dura reflected from the posterior part of the flap to cover in the area from which the mass had been removed. After inspection and assurance that the wound was dry, the bone

flap was replaced. Grossly there was no evidence of involvement of the bone by the tumor so that this was considered proper. The galea and skin were sutured as usual in layers. The patient's condition on leaving the table was satisfactory. He received no ether at any time. The post-operative convalescence was uneventful. He is at present, January 20, 1928, in perfect health and working at his trade. [Fig. 3.]

*Pathological Report.*—Dr. N. Winkeiman, Philadelphia General Hospital. On removal the tumor weighed 150–160 grams. The dimensions were 5.5 x 5.5 x 4.5 cm. It is encapsulated firm, nodular and reddish in color. A section of dura 4 x 3.5 cm. is firmly attached to the tumor. Microscopically, in cell type, arrangement, and staining reactions, the tumor shows all the characteristics of a meningioma. [Fig. 4.]

#### CHANCRE COMPLICATING LACERATION OF HAND

DR. HUBLEY R. OWEN presented a patient, a police officer, who had been bitten on the hand by a prisoner. The wound proved unusually intractable and dark field examination demonstrated the spirochæta pallida. The blood Wassermann was plus four. The patient received vigorous antilutetic treatment and at present shows only a scar. Doctor Owen remarked that while chancre was undoubtedly an uncommon complication of such injuries, it had occurred in the experience of many surgeons.



FIG. 4.—View of tumor removed from Case II.

#### ACUTE SIGMOIDITIS

DR. E. L. ELIASON presented a patient, a man, age sixty-one, admitted to the University Hospital, May 5, 1927, with the chief complaint of pain in the lower abdomen. This pain was increased on defecation and urination. The present illness began forty-eight hours before admission with pain in the abdomen, followed by nausea and vomiting. There was pain in the rectum on defecation and pain and tenesmus on urination. Physical examination revealed tenderness in the right lower quadrant of the abdomen. There was no rigidity nor palpable masses. The anterior wall of the rectum was tender by digital examination. The white cell count was 24,000 and the urine was negative. On admission the temperature was 100, the pulse was 96 and the respirations were 20.

A diagnosis of acute appendicitis was made, and the patient was operated upon immediately. The abdomen was filled with cloudy fluid and an acutely inflamed appendix was found lying in the pelvis and was removed through a right gridiron incision. The appendix, though inflamed and covered with lymph, was not the picture of a primary appendicitis of sufficient severity to be responsible for the peritoneal condition. Search was further made for the trouble. Through this opening, a mass could be palpated in the pelvis, and

an exploratory midline incision was made revealing a sausage-shaped mass, involving about three inches of the sigmoid colon. The walls of the gut were thick, beefy and cedematous and covered with lymph. The mass was evidently inflammatory in character, possibly secondary to a diverticulitis, obstructing the lumen of the gut. The mesosigmoid was cedematous and so thickened as to prevent a satisfactory delivery of the mass. In view of the obstructive nature of the condition, a left inguinal colostomy was done and the lesion left *in situ*. A colostomy was performed through a left gridiron incision.

Six months after operation, a proctoscopic examination was made and a view of the sigmoid colon was obtained through both the anal and colostomy openings. The inflamed area had subsided and the gut appeared to be normal in every respect. Following this examination, the colostomy opening was closed and the abdominal wall was repaired. The patient is now perfectly well.

#### CHOLEDOCHODUODENOSTOMY

DR. E. L. ELIASON also presented a man, age sixty-four, who had been admitted to the University Hospital, service of Dr. O. H. P. Pepper. The chief complaint on admission was jaundice. For a year prior to admission the patient had noticed malaise, loss of weight and occasionally nausea and vomiting. For two months before admission, the patient had noticed jaundice, clay-colored stools and darkly colored urine. There was intense itching of the skin, but no pain. Physical examination revealed deep jaundice. A hard mass was palpated in the upper right quadrant of the abdomen. The urine contained bilirubin 4 plus. The Van den Bergh direct reaction was immediate and the indirect reaction was 9.0 units. The blood calcium was 10.1 mg. per 100 c.c. The pre-operative diagnosis was common duct obstruction. The gall-bladder was found to be greatly atrophied and fibrosed, being scarcely the size of the little finger. It contained no stones and practically no lumen. The common duct was dilated, containing clear fluid and no stones. The obstruction of the common duct was found to be due to a hard swollen head of the pancreas. The lesion of the pancreas was diagnosed as probably carcinoma. A T-tube was used for the anastomosis and a choledochoduodenostomy was performed. The gall-bladder was too fibrosed and insignificant to be available for anastomosis. The patient is perfectly well at the end of six months.

#### REPAIR OF COMMON DUCT

DR. E. L. ELIASON presented a third patient, a man, age thirty, who was admitted to the surgical service at the Philadelphia General Hospital, suffering with an external biliary fistula, following a cholecystectomy four months previously. During this period his stools were entirely free from bile. On January 7, 1927, the reporter, through a paramedian incision, dissected out the biliary fistula until the upper end of the divided common duct was exposed, the fistula leading directly into it. After a prolonged search and mobilizing the duodenum, the stump of the lower section of the common duct was found. This had healed over and was closed by a knob of scar tissue. Either at the previous operation a section three-quarters of an inch long had been inadvertently excised or retraction had resulted to that extent, as there was that length gap between the two portions of the duct. The short upper portion of the duct was not sufficiently long to reach either the portion of duct below or the duodenum. The gap was bridged by a piece of rubber tubing about 6 cm. long and of a calibre to fit snugly in the duct lumen. Four catgut sutures were then passed through both ends of the ducts and an attempt made to thus draw the two divided ends together. The sutures had to be tied, however,

The larger tumor mass contained much more fat and was therefore easily identified as coming from the greater omentum. On section it showed many large and small cysts. Between the cysts there was a firmer, whitish, œdematous tissue. In this portion of the cystic omentum the larger cysts were more widely separated and their walls somewhat thicker. Several representative areas of the tumor were taken for section. (See Fig. 1.)

*Microscopic.*—The histological picture varied considerably in the different sections examined. However the sections were sufficiently numerous and the changes sufficiently graded to permit an interpretation of the probable pathogenesis of the lesion. In the

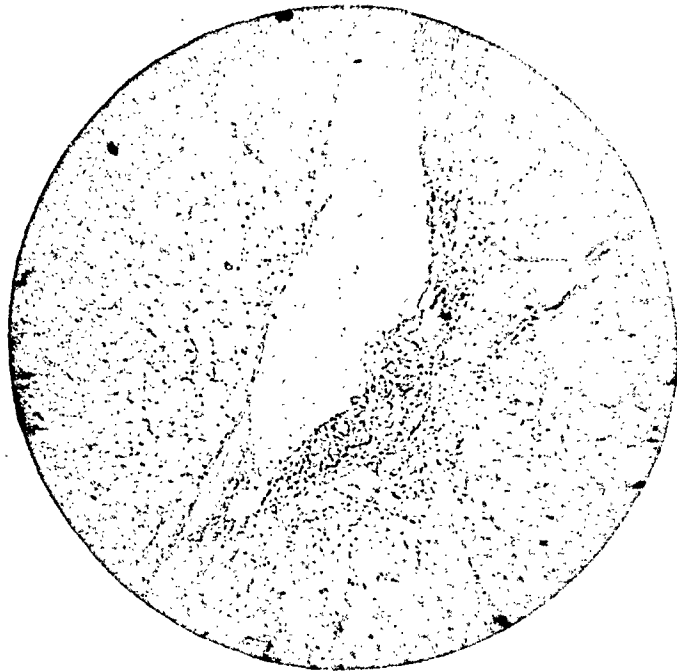


FIG. 2.—A widely dilated preformed lymphatic vessel in the omental fat.

more solid fatty portions of the omentum an irregular branching and plexiform dilatation of the preëxisting interlobular lymphatics was the predominating lesion. Some of these lymphatic spaces were empty, while others were filled with a pink-staining, granular, practically acellular material. Flattened endothelium lined these lymph spaces, though in some places there was hypertrophy and piling up of these cells two or three layers deep. At the intersections of these dilated lymph spaces processes were seen extending into the lumens. These processes were covered by endothelium, beneath which there was a connective tissue

framework, containing blood-vessels. At such intersections many new lymphatic vessels were also seen. These channels were plexiform, rather narrow, and lined by hyperplastic endothelium, one to four cells thick. Some lymphocytes were seen in the supporting stroma between the channels, which was rather œdematous and contained in addition many leucocytes. Other sections of this tissue showed more intense leucocytic infiltration with granulation tissue on the surface of the omentum where it was adherent to the surrounding tissues. These changes were interpreted as due to dilatation of the preformed lymphatics with secondary proliferative changes and tissue reactions due to the irritation of mild pressure. (See Figs. 2 and 3.) Tissue in which the tumorous nature of the lesion was apparent was found particularly between the cysts. Here there was an undifferentiated mesenchyme in which lymphangioblasts produced in places a granulation-like tissue. In these sections stages of the progressive enlargement and growth of the newly formed lymphatics produced in the granulation tissue were also seen. In addition the tissue showed diffuse leucocytic and lymphocytic infiltration. (See Figs. 4, 5, and 6.)

The large cysts were seen in a stroma of loose connective tissue. In the sections most of the cysts were empty while some contained a pink-staining granular material. The larger cysts which measured many low power fields in diameter were lined by flattened endothelium. Both sides of the dividing septa were covered by such endothelium supported by a connective-tissue layer. In the smaller cysts the lining endothelium was either hypertrophied or several cells thick. In some of the cysts there was evidence

## SPINA BIFIDA AND CRANIAL MENINGOCELE

leaving fully a half inch gap bridged by the tube. A catgut ligature left long was placed around the exposed portion of the tube and the ends brought up and tied to the abdominal wound edge, thus anchoring the tube to prevent it slipping beyond the defect. The wound was closed with a cigarette drain leading down to the repaired area. In spite of imperfect wound healing there was no escape of bile and the patient has had a complete recovery. The tube is shown by the X-ray to be still in the upper abdomen one year later.

## PROSTATIC MIDDLE LOBE HYPERTROPHY

DR. ALEXANDER RANDALL read a paper entitled The Genesis, Morphology and Surgery of Prostatic Middle Lobe Hypertrophy.

DR. A. P. C. ASH-HURST said that Doctor Randall had done notable work in the preparation of the specimens upon a study of which his paper was based. It is very interesting that he has found out a reasonable explanation for the different way in which the prostate may be enucleated: sometimes in one piece, sometimes in three pieces. All surgeons have had such experiences and they often thought their failure to enucleate the prostate in one mass in certain cases, was the fault of their particular way of operating on that individual patient. The speaker was sorry that Doctor Randall had not discovered just what an "enlarged" prostate is: whether it is an hypertrophy, an hyperplasia or a tumor. He saw no reason why it should not be tumor; this would be a very satisfactory solution, for then we would have no reason to look for a special cause until the general question of the cause of tumors can be settled.

## SPINA BIFIDA AND CRANIAL MENINGOCELE

DR. THOMAS A. SHALLOW read a paper with the above title.  
DR. FRANCIS C. GRANT said that he had not operated upon a case of meningocele for three or four years; the difficulty with such cases being that

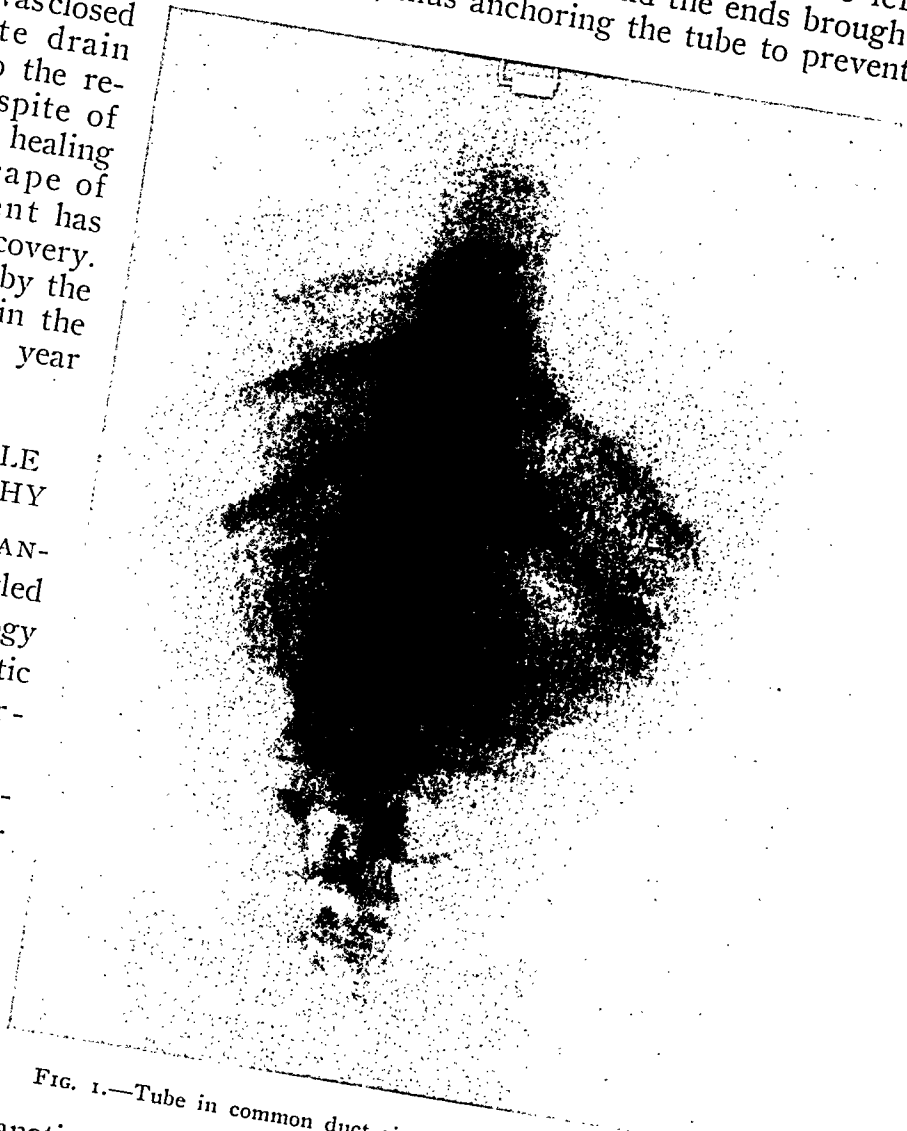


FIG. 1.—Tube in common duct six months after operation.



## PHILADELPHIA ACADEMY OF SURGERY

most of them are brought in the first few months of life with large sacs; frequently with sacs that have ulceration and with large bony defects in the spinal canal as shown in the X-ray; *i.e.*, the spinal cases; the cranial cases have brain protruding into the sac and the speaker regards this as a contra-indication to operative procedure. Regarding the post-operative development of hydrocephalus Doctor Grant believes that the spina bifida acts as a safety valve for the internal hydrocephalus and, in a large majority of cases, removal of the meningocele results in a secondary hydrocephalus. A large series of cases is reported by Cutler of Boston (*Archives of Neurology and Psychiatry*) in which he had 50 cases, 39 of which were operated upon; 16 of these died, the deaths being distributed as follows: 4 hydrocephalus; 4 hydrocephalus plus meningitis; 4 meningitis; 4 to pneumonia and other causes. Of the 39, 8 were alive after the five-year period and in good condition. It would seem therefore that if one has the courage to attempt this type of surgery, and its limitations are understood, a good deal can be done for the patient. From a sociologic point of view, it is a matter of prolonging life of children who will be burdens on society or who may show mental defects. Favorable cases should be given the benefit of the doubt.

DR. THOMAS C. SHALLOW said that of the ten cases operated upon 3 died within three days; 1 died in sixteen days of meningitis, and the other 6 are still living. There has been no return of the spina bifida and there has been improvement in 3 of the cases. The speaker does not regard the correction of bony defects in the spine as any more difficult than those in the head. Post-operative hydrocephalus is an important factor but as its occurrence can not be foreseen, it should not stand in the way. Two of Doctor Shallow's successful cases had ulceration of the sac when first seen.

# TRANSACTIONS

## OF THE

# NEW YORK SURGICAL SOCIETY

STATED MEETING HELD JANUARY 25, 1928

The President, DR. FRANK S. MATHEWS, in the Chair

### FRACTURE OF THE NECK OF THE FEMUR

DR. SETH M. MILLIKEN presented a woman, fifty-five years of age, who was admitted to the hospital from ambulance, October 28, 1926, late afternoon. While crossing the street one-half hour before admission she had been knocked down by an automobile. She was unable to stand. Examination showed the right leg shorter, adducted and rotated outward. The right trochanter was palpated one and one-half inches higher than the left. Immediate X-ray completed diagnosis of fracture of neck of femur.

The treatment immediately applied by resident surgeon was suspension and skin traction. X-ray, the following morning, showed fragments in fair position with coxa vara due to insufficient abduction.

The assistant surgeon removed the traction and improperly applied a Whitman case. X-ray showed shaft displaced upward necessitating re-reduction.

November 5, tongs were applied in the upper limit of femoral condyles with suspension and abduction, with the Thomas splint and Pierson leg piece. The Pierson leg piece was hung in balance so that the patient could flex and extend the knee by adjusting the overhead weight. This suspension permits motion at the ankle and knee under the control of the patient and maintains the tone of all muscles of the extremity. Spontaneous contraction of the quadriceps is necessarily limited during the application of the tongs but shortly after the removal of the tongs voluntary control of the quadriceps is regained. The inward rotation of the femur is maintained by the flexion at the knee. Twenty-five pound weight attached to tongs for thirty-six hours gave over-correction of shortening. Weight then reduced to eighteen pounds maintained fragments in correct apposition.

X-ray, November 10, showed fracture surfaces in contact with too great abduction. This was corrected.

November 16, traction weight reduced to thirteen pounds.

X-ray November 29, showed fragments in contact.

Tongs were removed on the twenty-seventh day, and skin traction applied without changing position of extremity.

December 10, patient showed voluntary power of quadriceps muscle.

December 29, callus was shown in X-ray.

December 31, voluntary motion at the hip-joint was present in what seemed to be normal arc.

January 13, suspension was discontinued. At this time extension at knee-joint was limited at about 165 degrees due to the long continued suspension with flexed knee.

February 11, (about thirteen weeks) patient was allowed to walk with crutches.

Four months after application of tongs there was full extension in hip and knee and full control of thigh muscles. Patient discharged improved March 10, 1927, nineteen weeks after admission, able to bear some weight

## NEW YORK SURGICAL SOCIETY

on injured side, 80 per cent. of normal motion in hip, and extremities equal by measurement.

Used crutches part of the time for following three months, since then has been walking with a cane.

X-ray taken last week shows complete bony union between the neck and the shaft with straightening of the angle between these two. The lesser trochanter is still displaced but the plane of fracture is undiscoverable at this time.

The case is shown because of the good reduction accomplished by this method and because of the comfort of the patient during the treatment.

Traction suspension seems the most satisfactory method of obtaining reduction of fractures in the thigh and arm bones. The disability of the patient is lessened because if the traction is applied in such a manner that the function of the muscle is maintained throughout the treatment, that is, if voluntary motion of the adjacent joints can be permitted without displacing the fragments, the muscle tone is maintained and union is hastened by the maintained nourishment of the part, which does not show the atrophy inevitable under treatment by immobilization.

DR. JOHN J. MOORHEAD said that Doctor Milliken's patient illustrated the advantage of strap traction over plaster-of-Paris. The patient he presented had no observable limp or eversion of her foot in walking across the room. Personally, the speaker had no experience in treating fracture of the femur by any form of skeletal traction. During the past year in nearly all of his cases he had used strap traction instead of plaster-of-Paris and found it very useful, especially in debilitated and aged persons who so frequently suffer from fracture of the neck of the femur. Doctor Moorhead showed röntgenograms of two patients. The first series was of a woman ninety-two years of age who had slipped and fallen, and sustained an intracapsular fracture of the femur in March, 1926. Pictures taken on that date and in October, 1926, and April 11, 1927, showed progressive repair. The patient is able to walk with the aid of a cane and one person. She is the oldest patient he has had. The other series of X-rays were those of a woman eighty-eight years of age whose fracture of the neck of the femur was also the outcome of a slight trip and fall. She had a stiff knee and the shaft was driven through the neck and through both trochanters. Traction of fifteen pounds was applied. The pictures were taken on December 10, 1927, at the time of the accident, on December 19, and on January 19th, and the last two show evidence of bony repair.

Doctor Moorhead wished to emphasize everything Doctor Milliken said of the advantages of strap traction over immobilization and plaster-of-Paris in this type of patient.

DR. CLAY RAY MURRAY said that one difficulty with strap traction in the treatment of fracture of the neck of the femur was that the skin will not stand any large amount of weight and this form of treatment requires a good deal of weight to get results in the overcoming of shortening and the maintenance of relatively fixed abduction. To overcome this deficiency he had tried out the idea of applying a double set of traction straps, one set

## FRACTURE OF CAPITELLUM OF HUMERUS

attached to the leg and one to the thigh, as the leg lies in wide abduction in a Thomas splint. To each set of straps twenty-five or thirty pounds can be attached without too much skin irritation from the pull, giving sixty pounds traction to correct the shortening, and better fixation for the abduction. This also solves the difficulty that one meets in skin traction in that if one of a set of straps comes off the other set is still working, and maintains at least twenty-five or thirty pounds of traction until such time as the loosened strap is renewed, instead of the patient being without strap traction at all in the interim as is the case when one of a single set of straps gives way.

### INTRACAPSULAR FRACTURE OF THE CAPITELLUM OF THE HUMERUS

DR. FENWICK BEEKMAN presented a woman, age thirty-seven, who on August 14, 1927, tripped and fell, landing on her extended right arm. She immediately complained of pain about her right elbow and found she was unable to flex or extend her forearm, it being held in a position of about 135 degrees.

She was seen one hour later at which time she complained of pain about her right elbow and down the volar surface of her forearm. There was no localized point of tenderness, though any attempt to move her arm accentuated the pain. The arm was placed in a sling and on the following day, an X-ray which was taken, showed a fracture about the external condyle of the humerus with, however, no marked amount of displacement. The patient refused an anæsthetic and therefore the arm was placed at a right angle, in an anterior-posterior moulded splint. At no time was there any swelling or ecchymosis seen. Motion was started in about three weeks and continued until October 20, about a period of two months after the injury, but the range of motion was not increased, it being limited to within an arc between 135 and ninety degrees. There was no interference in supination or pronation of the forearm and there was no pain as long as the motion at the elbow was not forced. At this time it was also noted that there was a slight loss of carrying angle. An X-ray taken showed an intracapsular fracture of the capitellum of the humerus, the fragment having been forced up and anterior to the remaining portion of the external condyle of the humerus by the head of the radius, which impinged upon it, when the arm was flexed to a right angle. There was no sign of callus. (Fig. 1.)



FIG. 1.—Intracapsular fracture of the capitellum of the humerus, showing the displacement of the fragment and the lack of callus formation.

November 14, the patient was admitted to the Ruptured and Crippled

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Hospital and the fragment of the capitellum was removed. An incision was made on the anterior surface of the elbow-joint in the groove between the supinator longus and the brachialis anticus muscles. The muscular-spiral nerve was found and retracted outward. The anterior capsule of the elbow-joint was found bulging forward. A crucial incision was made in the capsule and the fragment was easily removed as it was held by only a few adhesions of fibrous tissue. The rent in the capsule was repaired with chromic catgut and the overlying tissues were closed over it without drainage. The arm was placed in a position of about seventy degrees.

Active motion was started two days later and physio-therapy ten days after operation. The patient now lacks only about ten degrees flexion and about twenty degrees extension. There is a loss of carrying angle. X-ray shows a normal end of the bone with the exception of the capitellum which is missing from the humerus. There is no deposit of callus.

This case is presented because of the rare type of fracture. Its full extent was not recognized at first and the question now arises whether it would have been possible to have reduced the fragment and held it in its position when it was first seen? If it had been reduced would union have taken place? Doctor Beekman thought that it would have been impossible to have kept the fragment in position if it had been reduced, and that union would have not resulted, as the fragment was apparently free within the joint.

### PLASTIC FOR ULCER OF THE LEG

DR. FENWICK BEEKMAN presented a woman of forty-five years of age, who was admitted to Lincoln Hospital, February 12, 1926, with an infected ulcer about the left ankle. This had been present for three months. It healed rapidly when she was put to bed but as soon as she was up and about it broke down. On two occasions, while in the hospital, it healed followed by its reappearance, as soon as she was allowed up. The ulcer was situated just below and posteriorly to the external malleolus. Its edges were irregular and its base was clean. It was oval in shape measuring about one and a half inches in length by one inch in width. It was attached to the under-lying deep fascia of the ankle.

In the middle of July, 1926, the patient was placed in bed and the ulceration healed. On the 2nd of August a wedge shaped piece of skin, with its base down and including the scar of the ulcer, was excised. A pedicle flap from the dorsum of the foot was raised and rotated on its pedicle posteriorly into the position from which the ulcer had been removed. A full thickness Wolfe skin graft was removed from the thigh and sutured in to the position from which the pedicle flap had been removed.

On the seventh day the dressings were removed and it was found that the pedicle flap had healed in its new position and that the full thickness graft had completely taken. In about a month's time the patient was allowed out of bed and since then there has been no re-occurrence of the ulcer.

This patient is shown to demonstrate the possibility of using pedicle flaps and full thickness skin grafts in certain types of ulcers of the leg. Apparently the ulcer, in this case, was due to a lack of local blood supply. By using a pedicle flap to cover the defect, from which the ulcer had been excised, a new blood supply to the part was established by means of the vessels in the subcutaneous tissue of the flap, these vessels being guided from a healthy portion of the limb by the flap.

### CARCINOMA OF THE RECTUM. LATE RESULTS

CASE I.—DR. ALLEN O. WHIPPLE presented a woman, age forty-seven, who came to the Presbyterian Hospital, out-patient department, June 8, 1922,

## CARCINOMA OF THE RECTUM. LATE RESULTS

complaining of dyspnoea on exertion, palpitation and precordial pain. She gave a typical history of attacks of acute rheumatic fever, very severe one year ago. In the course of eliciting her system diseases, she said she had for the past year been severely constipated and had noted bleeding from the rectum fairly frequently, at times in fairly large amount. She complained of no rectal pain or tenseness.

*Physical examination* revealed a marked pallor, an enlarged heart, rate 100, with signs of mitral stenosis and regurgitation. *Rectal examination* showed a typical narrowing of the lumen with a hard nodular movable mass on the left and posterior aspect of the rectal wall 12 cm. from anal margin. A small section removed by proctoscope showed carcinoma. Hæmoglobin 45 per cent. Red blood-cells 3,000,000. Wassermann reaction negative. The patient was transfused and two days later under gas and ether anæsthesia a radical abdomino-perineal removal of the pelvic colon, rectum and anus by the Myles technic was done in one stage, using a left lateral colostomy. She made a satisfactory recovery, her heart behaving very well during and after the operation. She went home on her twenty-eighth day with wounds healed. It is now sixty-nine months since her operation. Her only complaints are related to her cardiac lesion. Colostomy functions satisfactorily and when last seen in November she showed no signs of local recurrence or abdominal metastases.

CASE II.—Male, age forty, was admitted to the Presbyterian Hospital, out-patient department, May 25, 1922, complaining of bleeding by rectum, repeated painful ineffectual defecations, loss of eighteen pounds in one month. Past history and his present system history was essentially negative. He had had no treatment for his present trouble. He was a rather pale, apprehensive man, complaining bitterly of his constant desire to empty his rectum. General physical was negative. No cardiac or pulmonary lesion. Liver not enlarged. Rectal and proctoscopic examination revealed an annular growth 8 cm. above the anus, not attached to sacral wall. It was questionable as to its attachment to the bladder wall. Section showed adeno carcinoma. Urinalysis and Wassermann negative. Phthalein 48 per cent. Blood Urea 0.35 grm. per litre.

June 12, 1922, a one-stage combined abdomino-perineal removal of pelvic colon, rectum and anus with left lateral colostomy by the Myles technic was done. The patient stood the procedure well and made good progress for five days. But on the evening developed a cough and hiccup and on the sixth day he complained of sudden pain in the upper angle of his abdominal wound and on examining the dressing it was found that a loop of ileum had protruded through the upper angle of the wound. This was repaired immediately under local anæsthesia and the subsequent course was uncomplicated save for threatened decubitus requiring an air bed. His perineal wound filled in slowly so that he did not leave the ward until the fifty-second day after operation.

He has been examined ten times in the Surgical Follow-up. The last time in October he gave no evidence of local recurrence or abdominal metastases. He has maintained his normal weight and is working regularly. It is now sixty-eight months since his operation.

CASE III.—Male, age fifty-six, admitted December 28, 1922. Six months prior to admission had attack of mild diarrhoea for one month—no blood. All right till five weeks ago—return of diarrhoea with ineffectual evacuation. Fresh blood in stools. No pain. Loss of five pounds in five weeks. Marked weakness and exhaustion, underdeveloped and undernourished. Marked myo-

pia. Bad teeth. Lungs and heart negative. Right inguinal hernia reduced. Blood pressure 128/80. *Rectal*.—Irregular firm cauliflower mass on posterior wall, not involving anterior wall. Freely movable. About 8 cm. long. No ulcerations felt. *Laboratory*.—Red blood-cells, 4,900,000. Hæmoglobin 83 per cent. White blood-cells 10,000. Polymorphonuclears 84 per cent. *Diagnosis*.—Cancer of rectum. Confirmed by pathological report date of operation, December 30, 1922. Combined abdomino-perineal resection of rectum in one stage. Pathological report shows metastases in several lymph glands and tumor invading muscularis. The feeling was that it was not all removed.

*Course*.—Very restless and mentally unstable for about ten days post-operative. This at first attributed to poor urinary excretion for the first four days and paralytic ileus for four days. Daily blood ureas averaged 0.8 gms./L and uræmia was questionable. On fourth day had good bowel evacuation through colostomy. Iodoform poisoning suggested and urine found iodine + + + +. Packing removed and symptoms gradually cleared up. Patient steadily improved. Wounds all healed cleanly. Abdominal wound healed. Rectal wound five and one-half inches lined with clean granulations on discharge.

Patient seen ten times in Surgical Follow-up with 444 result. Admitted again five years after operation with strangulated right inguinal hernia. Hernia repaired and patient discharged after good recovery in good condition, December 21, 1927.

#### ULCERATIVE COLITIS

DR. HAROLD E. SANTEE read a paper with the above title for which see page 704. To illustrate his paper Doctor Santee presented two patients, as follows:

CASE I.—Man, age forty-six, admitted to Bellevue Hospital, December 5, 1926. His previous history is apparently relevant in its surgical aspects only. He had been operated upon for the following conditions: Hemorrhoids in 1908, appendicitis in 1913, cholecystitis in 1916. Three years prior to admission he suffered for six weeks from an illness similar to the present followed by a long remission with constipation. About six weeks ago he began to have diarrhœa with rectal tenesmus and his stools gradually increased in number to twelve or fifteen a day. Colicky pains were present at times. The stools have been black at times, sometimes "pusy" and mucoid, sometimes showing obvious blood. Mild fever has been present at times. During the past week, however, all symptoms have been increasing until two days ago pain in the abdomen, prostration, dehydration and fever in addition to the bloody diarrhœa and tenesmus caused him to call a physician. Vomiting occurred two days ago. Diarrhœa and tenesmus have been the two most distressing symptoms.

Examination after admission to the Hospital showed a well nourished man in obvious pain with evidence of some dehydration in mouth and tongue. The temperature was spiking to 102.4. The urine and blood chemistry were normal. The blood picture showed: Hæmoglobin 100 per cent., white blood-cells 13,600, polymorphonuclears 77 per cent. Physical examination showed a rounded somewhat distended abdomen with definite tenderness and rigidity in the left lower quadrant. At times a sense of mass would be made out here. Rectal examination was very painful and showed exquisite diffuse tenderness within the sphincters and a small recent fissure anteriorly in the anus. Rectal irrigations were started and proctoscopic examination

## ULCERATIVE COLITIS

attempted but were too painful to the patient. Increasing left lower quadrant tenderness and rigidity caused considerable apprehension to the surgeon and on December 9, 1926, exploratory operation was done through a lower left rectus incision. The entire rectum, sigmoid and descending colon were greatly thickened, œdematous and congested, the changes being most marked in the sigmoid which showed numerous fibrinous plaques and to the parietal fine adhesions both to adjacent coils of small intestine and the exudative peritoneum. Sacculations of the gut were obliterated by the splenic flexure process, mesocolon was œdematous, even gentle handling produced small areas of stippled hemorrhage. The colon proximal to the gall-bladder and appendix scars. Cultures were taken from the wall of the colon (reported sterile) and the wound was closed. Dilatation of the sphincter ani was then done and the patient returned to the ward. A broth diet with small repeated doses of deodorized tincture of opium, daily emetine injections, and rectal irrigations failed to show improvement in fever, diarrhoea and tenesmus. Five days after exploration, cœcostomy was done through the old McBurney scar. The opening was made into the cæcum on the following day. Hot saline and hot tap water irrigations were instituted twice a day. The broth diet with opiates was continued. The temperature became normal on the eighth day following cœcostomy only to rise slightly again and range between 99 and 100, until the fortieth day. Milk and soft foods of low residue were gradually added to the diet. On the seventeenth day after cœcostomy a transfusion of 500 c.c. of blood was given. Irrigations were changed to potassium permanganate solution (1-8000) after the first two weeks due to the bacteriological reports and these were kept up until the fiftieth day when he was having one formed stool a day. After the cœcostomy and with the irrigations the stools decreased in number from fifteen to twenty a day to six or eight and the blood disappeared at the end of the first week. These stools were very purulent and looked like a pyocyaneus pus which they later proved to be.

The bacteriological reports on the stools as made by Doctor Torrey were as follows:

December 16, 1926. Serous fluid with clots of blood and fibrin. *B. coli* and *B. pyocyaneus* extremely numerous. The *B. coli* were not virulent. No streptococci recovered.

December 21, 1926. Purulent fluid, no fecal matter. Gram stained film shows many pus cells. No chain streptococci. Gram-positive diplococci (enterococci) and single cocci numerous. Cultures show *B. coli* and *B. pyocyaneus* as in first specimen. Also some coccus colonies—staphylococcus (pale aureus). In an anaërobic fluid culture many streptococci were seen in the stained film, some of these in diplococcus and some in long chain forms. These would not grow on aërobic plates and have not been isolated. They are apparently anaërobic types and are more likely than anything else found to be a primary factor in the colitis. It is also unusual to find such large numbers of *B. pyocyaneus* in the colon and it is possible that they may have a secondary rôle in the inflammatory process.

January 3, 1927. The *B. pyocyaneus* which were so prominent in the first two specimens have disappeared. Some long chained streptococci developed in the cultures of the same morphology as seen in the previous specimens. It is likely that the primary factor at this time consists of light the *B. pyocyaneus* secondary. The specimen consists of light brown fecal lumps, with no blood and some mucus and it is of interest that



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the *B. pyocyaneus* has disappeared coincidentally with the improvement in the character of the stool.

Improvement in the patient was progressive and after the fiftieth day he was up and about with one stool a day. One irrigation a day was given. After five weeks of afebrile symptom-free convalescence the cæcostomy was closed on the eighty-seventh day after operation. In another three weeks he was discharged from the hospital and has remained well since.

CASE II.—This patient, a woman, age forty-five, on admission to Bellevue in 1923, was shown to illustrate the late effects of a subacute or chronic colitis. At exploration in June, 1923, her sigmoid and descending colon together with the mesocolon were thickened throughout, rather firm in consistency, but showing small stippled hemorrhagic areas wherever handled. On a dietetic régime, she continued for fifteen months with increasing constipation. At this time a short tubular stricture of the rectum was made out but not markedly constricting. At operation with a view to cæcostomy in September, 1924, the same changes in the cæcum and ascending colon were noted as in the sigmoid on the previous operation. Cæcostomy was done and irrigations given for six weeks. She was allowed to go home and the cæcostomy closed spontaneously after approximately eight months. A small cæcal hernia repair was done the following year.

She remains well but constipated and shows on examination at this time a hypertrophy or thickening of the colonic wall that is very obvious on palpation. Her stricture of the rectum seems to be of the same calibre as on previous admission and admits the index finger fairly readily. The mucosa is apparently normal in appearance and feel and the stricture is probably due to old inflammation within the wall of the colon with restitution of the mucosa to practically normal.

DR. WALTON MARTIN remarked that at the outset in any discussion on colitis it is well to keep clearly in mind that the term ulcerative colitis or dysentery is used to designate a number of specifically distinct diseases; that we have protozoa colitis, bacillary colitis and ulcerative colitis from the ingestion of certain toxic substances. In the protozoa and bacillary forms the microparasites seem to set up lesions beneath the mucosa and as the lesions progress there is destruction of the glandular coat by necrosis or by an infiltration of round cells, so that numerous ulcers are left. It is difficult to think that any solution flushing the surface will do more than carry away fibrin, necrotic fragments and surface bacteria and thus prevent secondary infection and decomposition of the colon contents. The amœbæ or bacteria beneath the ulcerating surface are not reached by the antiseptic solution.

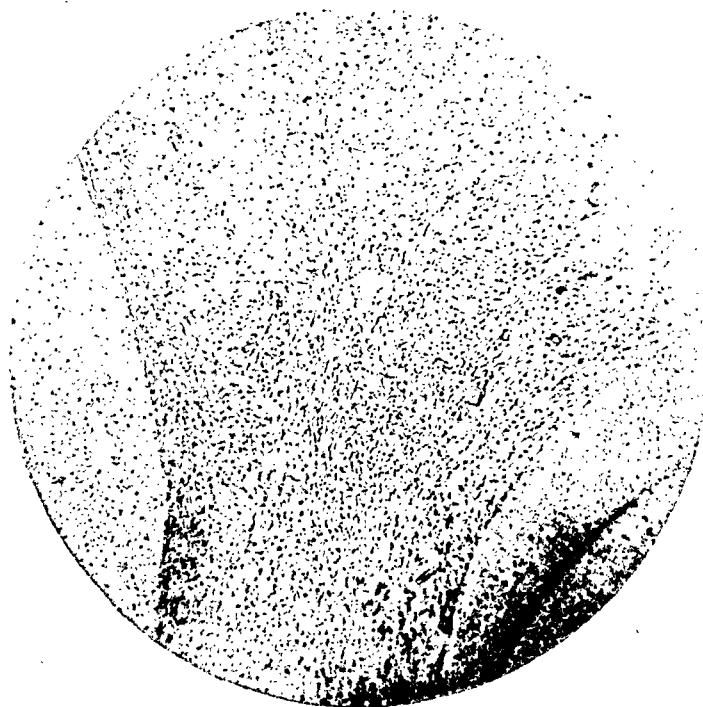
The function of the colon is, as all know, to take up fluids and convert the semi-fluid contents of the small intestine into solid feces.

In colitis this function is interfered with. Not only is the fluid not absorbed but a variety of putrefactive changes in the unabsorbed intestinal contents occur with the formation apparently of acrid substances which irritate the mucosa. Regular flushing has an important therapeutic action in washing out these irritants, but can it not be accomplished effectively by colonic irrigation given through the anus? Diverting the contents of the small intestine, added to flushing, must accomplish the same purpose in a

FIG. 3.—Numerous communicating and branching preformed lymphatics with hypertrophied endothelium.



FIG. 4.—Undifferentiated mesenchyme between some larger cysts.



## ULCERATIVE COLITIS

better way. Both measures, however, simply attempt to create conditions more favorable for the body cells. They do not affect, except indirectly, the underlying infection. These conditions hold for all ulcerative colitis irrespective of etiology.

A review of the several operations which have been devised to either irrigate the colon or prevent the contents of the small intestine from passing through the colon may be pertinent to the discussion.

Seventeen years ago, Doctor Gibson of this Society read a paper on the Surgical Treatment of Colitis before the International Society of Surgery at Brussels and referred to an earlier paper on a valvular cæcostomy for chronic colitis, written in 1902. The method he used was a cæcostomy done much as the Kader operation is done in the stomach. About the same time, Weir, stimulated by Doctor Gibson, introduced appendicostomy. Since then, every now and again, cases are shown demonstrating marked improvement after irrigation through either the cæcum or appendix.

Doctor Elliot showed a patient before this Society, about eighteen years ago, suffering from amœbic dysentery treated by performing appendicostomy and irrigating the colon with quinine. It was evident in the discussion at that time that a permanent opening was the aim and that recurrences were expected. Now-a-days Stovarsol (introduced by Marchoux of the Pasteur Institute in 1925), a synthetic chemical compound which seems to be a powerful amebicide, would probably have cured this patient.

Doctor Santee has properly reached the conclusion that cæcostomy is a more satisfactory operation than appendicostomy and advocates a liberal opening, (one to one and a half inches), so that not only can the bowel be irrigated but the fecal contents of the colon pass out through the opening to some extent, a condition carefully avoided in the earlier technic. Doctor Martin expressed the belief, however, excluding the large bowel altogether by an ileostomy is a better operation, notwithstanding the theoretical disadvantage of the difficulty of closure of the ileostomy. A case was reported a few years ago by Dr. Harvey Stone in which the patient gained sixty pounds and was well and free from all symptoms two years after the closure of the ileostomy.

It seemed to the speaker inadvisable to do any operation until the chronic ulcerative colitis has resisted medical treatment for a number of months and until symptoms of a severe exacerbation have made their appearance.

In closing, Doctor Martin referred to the statement that the first clinical description was Sir William White's in 1888. Aside from others, the late Francis Delafield of this City was especially interested in all forms of colitis. His autopsy reports and case histories date back to the Seventies. He has given accurate descriptions of the morbid anatomy of the various forms of colitis with case histories.

Besides the protozoa and Shiga-Kruse and Flexner bacillary dysenteries, there are apparently a number of other forms usually grouped under the general term idiopathic colitis. Doctor Santee has referred to the work of

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Jacob Bargen at the Mayo Clinic who has described a Gram-positive diplococcus as a specific infecting agent in patients with this form of colitis, who have come under his observation, but those competent to decide seem most doubtful of the value of his work. He has cured or greatly relieved his patients by the removal of small local foci in tonsils, roots of teeth, etc., in which he has found the same diplococcus, added to treatment by vaccines and topical applications.

DR. EDWIN BEER said that in making the correct etiological diagnosis, he had had great difficulty in distinguishing between the specific amœbic and the non-amœbic cases. Emetin administered hypodermically did not assist in the differentiation whereas proctoscopy and the study of the stools had at times helped. In the typical non-amœbic cases at proctoscopy he had noticed punctate ulcers, whereas in the amœbic cases, he had found large irregular undermined ulcers. All cases do not require surgery and many are treated—even quite serious cases—satisfactorily medically.

In one case of severe hemorrhagic ulcerative colitis, in which the patient had had two attacks and had to be transfused, the condition was controlled by medication and colonic irrigations. Subsequently, the patient developed acute gangrenous appendicitis for which he was operated on, and during convalescence the colitis again became troublesome, and without doing anything surgically to the colon, under medical treatment the colitis was controlled once again and the patient has been in good health for almost two years. It was impossible to prove in this case what the etiological factor was.

If one decides that the case does not respond to medical treatment, the question comes up, should one regularly do a wide artificial-anus operation in the ileum or cæcum. Having had excellent results with the valvular cæcostomy—the appendix having been removed at the same sitting—he would prefer to do this operation as a first-step, and if it failed, he would favor a complete ileostomy.

The oldest case of ulcerative colitis that he has had under observation continuously was a young woman who had a cæcostomy of this type done eleven years ago for a very severe ulcerative colitis with high temperature. The patient was desperately ill and had not responded to medical treatment, and at operation the cæcum and colon were studded with white plaques of localized suppuration. Her proctoscopy had shown multiple pinhead superficial erosions; no amœbæ and no bacteria with gram-stain. A large rectal tube was sewed into the valvular cæcostomy allowing almost all the stool to be diverted. After four days irrigations of the bowel were begun, and later on emulsions of bismuth were run into the colon through this tube. The patient made a satisfactory convalescence and the tube was left in with the object of controlling any relapse, the size of the tube being reduced to that of a small catheter—about 12 to 14 fr. The patient relapsed in a few months, and irrigations, first with silver nitrate and subsequently with ichthyol 2 per cent., were instituted. The latter irrigations apparently controlled the condition rapidly as the stools became normal, mucus and blood disappearing.

The cæcostomy wound never leaked and there was no soiling and no discomfort. For two years the patient was in excellent health even passing through a severe attack of influenza, and she gained thirty pounds. There was on several occasions a little blood just preceding defecation, apparently from local irritation; there was no diarrhœa and the stools were regular and formed. In 1921, seven years after operation, the patient continued in the same excellent condition having required only three irrigations of her colon during the past twelve months; she was able to attend to all her activities normally. In 1922, she had an occasional attack of cramps in the abdomen and occasionally several movements. She went to Cuba in this year where, following exposure or indiscretion in diet, her diarrhœa came back, and while out of town she attempted to control the condition by flushing the bowel with bicarbonate of soda. On returning to New York her condition again was serious and temperature elevated. Under careful irrigations, the condition was controlled. Repeated examinations of the stool had been made and on one occasion amœbæ histolitica were demonstrated in 1922 by one Laboratory. Following the relapse of 1922, the patient has remained perfectly well so that in December, 1927, the tube, which had been in ten and one-half years, was removed and the patient continues in excellent health.

The experience with this case and others of similar character, indicate that it is risky to close the colon as these patients are very liable to have remissions which are easily controlled if one has access to the bowel by means of a valvular cæcostomy which can be maintained without annoying the patient for many years. If, on the other hand, these procedures fail to control the situation, the more radical procedure of ileostomy with complete severance of the small intestine, should be performed and one can continue medicating the colon through the original valvular cæcostomy. It is important in irrigating to use bland solutions so that one can really effectively wash off the surface of the colon; an irritating solution which produces peristaltic contractions prevents this complete lavage.

It would be most gratifying if the serum which has been elaborated at Mayo's would prove effective in these trying cases as despite all our efforts, the patients are liable to be sick a very long time and many of them become chronic invalids if they do not die of the ulcerative colitis.

DOCTOR SANTEE, in closing the discussion, said he believed it is extremely difficult to form proper conclusions in these cases marked by such diverse clinical courses but he considered cæcostomy such an easy operation that even were it necessary after closure of one cæcostomy, it could be reopened in case of another exacerbation. This would give an interval of freedom from the discomfort of a cæcal fistula even if another exacerbation indicated a second cæcostomy. As Doctor Hitzrot said at a previous meeting of this society, cæcostomy is a "dirty" operation but the disease is likewise a "dirty" disease and cæcostomy in this regard does not compare unfavorably with ileostomy. Moreover, it has the advantage of not being a serious operation

but in the opinion of the speaker should be done more for adequate drainage than for irrigation alone. It is simple, closure is simple and not hazardous and if necessary can be repeated perfectly well.

DR. HAROLD NEUHOF stated that, for purposes of discussion, he would like to split off from the general group of ulcerative colitis a series of cases in which the patients were seriously sick with profound anemia, septic temperature, tenesmus and very frequent diarrhoeal stools mixed with blood and pus. The question is whether palliative measures, or even colostomy, sufficed for cases belonging in this group. These cases go on to death unless some measure of definitive relief is employed.

Doctor Neuhof referred to a series of six cases belonging to this group on which he had operated, having performed an ileostomy in all of them. In two, a colostomy had previously been done without relief. The first case was done approximately three years ago; the last about six months ago. The immediate result was striking in all the cases. As soon as the intestine was opened the temperature dropped to normal and remained so, even when it had run a septic course for weeks or months. The discharge of blood and pus from the rectum rapidly subsided. There was prompt improvement in the anemia.

The point that Doctor Neuhof wished to emphasize was the fact that none of these patients can as yet be reported as cured, although all but one have been greatly relieved. He wished to stress this point because an impression exists that one can, at a reasonably early time, close an ileostomy or cæcostomy opening. Doctor Santee has shown that in selected cases a cæcostomy can be closed at an early date. It must be remarked, however, that in some of these cases the disease pursues an intractable course and may be characterized by long periods of remissions, later to be followed by severe exacerbations.

Summarizing the results in his six cases, Doctor Neuhof notes that in one case there was recurrence of hemorrhages and purulent discharges several months after operation, followed by multiple involvement of joints and a progressive downhill course. The final result is not known about this patient; probably he has died.

All the other cases are alive. One did well for months after operation and since that time has had recurrent hemorrhages with a varying amount of pus in the stools. Occasional transfusions have kept this patient in reasonably good condition.

The third patient is the one shown here tonight in whom a result that may be termed excellent exists, but in whom some purulent discharge from the large bowel remains. A fourth patient, operated upon about a year and one-half ago, is doing very well with only occasional discharge of small amounts of pus. A fifth case, operated upon about a year ago, is doing fairly well, but has mild recurrences of discharge of blood and pus from the rectum from time to time. The last patient is still in the hospital now improving

## ILEOSTOMY FOR ULCERATIVE COLITIS

progressively, but having done so badly for a time that colectomy had been considered.

In short, rapid recovery from an alarmingly serious clinical picture is the rule after ileostomy. The brilliant immediate result, however, is not evidence that the patient will be cured in any other than a long period of time after the establishment of complete drainage of the small bowel.

### ILEOSTOMY FOR ULCERATIVE COLITIS

DR. HAROLD NEUHOF presented a man, thirty-six years old, who came under observation a year ago with the following history:

Six years before, he began to have diarrhœa, with blood and pus in his bowel movements. Symptoms were at first mild, but became progressively more and more severe and incapacitating. The manifestations would be acute for a period of several weeks or a month and then there would be a relatively free interval in which there was little diarrhœa and a reduction in the amount of blood and pus in the stool. The remissions became shorter and less frequent. For six months before the time the patient came under observation, the manifestations became progressively worse. In all the acute phases of the disease, the patient has had some fever. For the last three months the fever had not only been persistent but gradually became septic in character. There was rapid loss of weight, pronounced weakness. Pain and tenesmus became agonizing and there was almost constant movements of small amounts of stool mixed with much blood and large quantities of pus. Various methods of treatment had been employed. The history of the patient indicates that they were thoroughly tried and that they included all the methods of non-operative treatment that have been advocated and that so-called specific vaccines have been employed. No method of treatment was discontinued until it was obvious to this intelligent patient that no result had been obtained. Upon two or three occasions, symptoms subsided with methods of treatment that had been employed, but the patient learned that such subsidences were the approach of a relatively free interval, rather than the effect of treatment.

On admission to the hospital the patient was profoundly anemic and asthenic. He had to be lifted on to the bed-pan for the almost incessant evacuation of blood, pus and diarrhœal stool. A spiked temperature ranged from normal to 104; pulse was rapid and weak. The abdomen was scaphoid, with rigidly held abdominal musculature. It was generally tender throughout. Large doses of morphine were administered without much relief of tenesmus and with no effect on the diarrhœal movements.

Operation, done a year ago under local anæsthesia, was preceded by a transfusion. A right-rectus muscle-splitting incision just below the umbilical level revealed a cæcum and ascending colon that were œdematous, infiltrated, with deep injection of the overlying serosa. A further exploration of the large gut was not made. The terminal ileum was drawn out of the wound and a site about five inches from the ileo-cæcal junction was chosen for the enterostomy. The mesentery of this loop was transfixed by a glass rod and then the loop was twisted ninety degrees. The two arms were sutured to the parietal peritoneum by fine catgut and the remainder of the short incision packed with iodoform gauze. A cage was placed over the wound.

After operation the patient's condition remained critical for several days, and there were severe cramps. The enterostomy loop was punctured with a Paquelin cautery on the second day. Temperature began dropping toward the normal and general condition began to improve on the third day. The

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glass rod was removed on the fifth day, the iodoform gauze pack on the sixth day. A week after operation the temperature was normal and has remained so ever since. With a dietary control, the enterostomy soon began to function adequately. At the present time there are usually two, sometimes three and four bowel movements from the enterostomy. There have been no bowel movements from the anus. The skin about the enterostomy has required considerable care in order to avoid irritation. There has been progressive diminution in the amount of blood and pus discharged from the rectum. In recent months blood has entirely disappeared and the amount of discharge of pus from the rectum is now from one-half to two ounces daily. There has been steady and progressive improvement in the condition of the patient. He has gained more than fifty pounds since the time of operation, is active physically, and suffers only from the necessity of caring for the enterostomy wound. From the time of convalescence from operation he has upon a number of occasions employed irrigations of the large bowel by way of a catheter that can be readily introduced through the enterostomy wound into the cæcum. These irrigations not only have proven of no value but they appeared to have tended to increase by irritation the amount of purulent discharge. Therefore, in recent months the patient has entirely discontinued irrigation of the large bowel.

The case is presented as one of intractable ulcerative colitis in which the disease has apparently been permanently arrested but not cured by long standing enterostomy. It is obvious that even after a year, closure of the enterostomy would not be justified.

### EDITORIAL ADDRESS

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## EPINEPHRECTOMY (ADRENALECTOMY) FOR HYPERADRENALINEMIA IN SPONTANEOUS GANGRENE\*

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OF LENINGRAD, RUSSIA

FROM THE SURGICAL CLINIC OF THE MEDICAL ACADEMY OF LENINGRAD, U.S.S.R.

For a long time the origin of the so-called cases of spontaneous gangrene has remained in obscurity. It has always been attended with serious consequences and usually ended in the amputation of the affected extremity if, as so often happened in the meantime, the patient did not die from intercurrent infection either from the effect of the toxins on the circulatory system or from gangrene of the intestines or thrombosis of other arteries.

It is essential to appreciate that in the beginning, spontaneous gangrene invariably is evidenced as a dry process and seldom becomes moist. This differentiation is necessary to remember as it will be noticed that Buerger's disease, termed "thrombo-angiitis," appears to be an appreciably different process from a spontaneous gangrene. Usually the thrombi develop in the superficial veins of the extremities, although the condition Buerger describes, as a rule, goes through a process of dry gangrene, the reason in both instances being similar and apparently due to the fact that there is an interference of the afflux of arterial blood to the peripheral extremities caused by thrombosis of the arteries. Occasionally the thrombosis of the superficial veins can be noticed in some of the patients but it is unusual. The thrombosis of the deep veins is rarely observed, while in cases of spontaneous gangrene the additional thrombosis of the deep veins changes it from the dry form into a wet one.

In cases of spontaneous gangrene in which I place those cases of thrombosis of the deep arteries, in order to increase the blood in the peripheral extremity, for a long time I have practiced the bandaging of the veins in the region of the hip. This has been likewise done by various other surgeons on many other occasions and it has been noticed that it usually gave some temporary benefit in that there showed a definite hyperæmia particularly noted on the dorsum of the foot and a general suffusion in the extremity with a consequent amelioration or disappearance of pain. Based on the above effect of bandages applied about the knee or hip, a series of palliative operations have been evolved such as the periarterial sympathectomy of Leriche and the severance of the sensory nerve trunks as developed by Molotkoff.

In instances of spontaneous gangrene, the arteries are similarly narrowed

\* Translated by Dr. Alexander S. Kasatchenko of Montreal, Canada.

or in a state of spasm and our efforts should be directed to any method which will cause dilatation of arterial collaterals. Previously, the surgery of many conditions of this type was developed on the pathological anatomy noted in the affected arteries and it had been appreciated frequently that in these cases the femoral artery, for instance, seemed to be especially small. It was therefore felt that the condition was the result of a congenital narrowing of the arterial lumen. This theory has, of course, now been rejected. Appreciating that in cases of spontaneous gangrene, the immediate cause was due to a blocking of the artery, caused the German surgeons to institute studies against what they termed "endarteritis obliterans" in which they demonstrated that the obstruction was caused by thrombi which extended both in an upward and a downward direction. This hypothesis of the development of this type of gangrene has been generally accepted, that thrombosis affecting first the arteries of the extremity and then continuing in other parts of the body so that it may develop further in the heart, intestines, brain and kidneys, etc. The question, however, arose, "What was the original etiology of the primary thrombus?" Buerger was inclined to attribute it to racial idiosyncrasy as most of his cases occurred in Jewish immigrants. However, the condition has been found in many other races and is particularly prevalent in the north-western part of the United States of Soviet Russia. It would, therefore, be apparently more reasonable to consider spontaneous gangrene as rather one of geographic than racial distribution. Irrespective of this factor, Buerger failed to explain the reason for the thrombus and what caused the disease of the arterial wall which, in some cases, terminated in a sclerosis of it, as was demonstrated definitely by T. von Manteufel, although in 1911 I advanced an hypothesis relative to the causation of this condition by considering it an hyperfunction of the adrenal bodies and that essentially the condition was caused by an hyperadrenalinemia. This was, however, met with severe criticism and I have attempted to justify my position by evolving proof both clinically and experimentally.

I termed the disease of the artery an arteriosis and hypothesized that under the influence of the stimulation of an excessive amount of adrenalin in the blood, the arteries were in a state of spasm which caused a derangement of the degree of nourishment to the arterial walls, with a consequent erosion of the endothelium and a resulting focus of lowered resistance of the muscularis with the eventual establishment of the so-called arteriosis, the succeeding formation of sclerosis, and the development of the local thrombus which, continuing to increase in size, eventually impinged upon the lumen of the artery, growing in both directions. Before starting to develop proof of the etiology of the condition being due to an hyperadrenalinemia, I wish to compare symptomatically spontaneous gangrene and Buerger's disease taking chiefly into consideration an article published by Vaquez who described the symptom complex of Buerger's disease in great detail and who was one of my harshest critics.

In Buerger's disease, there occurs an hyperglobinemia. This has similarly

been noticed by Gieberich in cases of spontaneous gangrene, or as I have termed it, hyperadrenal arteriosis in which condition there is very characteristically an hyperthrombositosis which has been calculated as high as one half million thrombocytes. It would be interesting to know to what extent this holds good in instances of Buerger's disease. In both conditions, there is apparently an hyperglycemia present as demonstrated by Obraszoff. In both conditions there is an increased viscosity of the blood which was demonstrated by Ditrogorsky. There is, in at least one-half of the cases of hyperadrenal arteriosis, a definite inhibition of the coagulating time. Parenthetically, I would like to call attention to the fact that hyperthrombositosis facilitates the formation of white thrombi and also that increased viscosity and accelerated coagulation time facilitate stratification of red thrombi. In Buerger's disease there is an increase of cholesterin in the blood. This was not noted in instances of hyperadrenal arteriosis (Sokoloff). It does not seem to me that this difference should be considered a valid reason for distinction between the two conditions when in the remainder, the findings appear identical. In addition, in typical instances of hyperadrenal arteriosis, there is an increased central arterial pressure as can be determined on the shoulder while there is a lowered peripheral pressure found in the fingers, which can be explained if the arteries are partially passable or if there is only an incomplete spasm of the peripheral arteries, also that in these cases the central arterial level of the blood is ordinarily higher and reaches 12 and even 13 milligrams of one per cent. After following Collip's investigation, it would seem feasible that the increased level of the central arterial blood tends to contribute toward a falling back of it to the side of arteries affected by hyperadrenalinemia. Is it not possible further that in such cases where we find an hyperfunctioning of the adrenals, might there not similarly be an hyperfunctioning of the epithelial bodies in general? It therefore seems to me that there is no real difference between Buerger's disease and hyperadrenal arteriosis, that they are both the same condition which can best be given the nomenclature of spontaneous gangrene.

Feeling that the above hypotheses and deductions were correct, I have for some time, for the cure of this disease, been performing a left-sided epinephrectomy (adrenalectomy). I have performed this operation on one hundred and thirty cases. At the present time there has been thus far but a very small mortality. In the last seventy epinephrectomies performed on account of hyperadrenal arteriosis or spontaneous gangrene, only two patients have died.

It has been noted that after epinephrectomy, the number of thrombocytes decreases, the level of the blood sugar decreases, even when it is normal at the time of operation, a reduction having been noted in one instance from .095 per cent. to .08 per cent. Co-incidentally, the central arterial pressure becomes lower but the peripheral blood pressure on the contrary rises, thus diminishing the balance because it would appear that as the result of the

peripheral arteries being dilated, the wave of blood attaining the periphery meets with less resistance.

When we realize that all the above enumerated data are to be observed during the course of the first weeks after epinephrectomy, which is time enough for all influences of an operation on the body to cease, it seems to me that it is fair to assume that the hyperthrombocytosis, hyperglycemia, increased central arterial pressure and lowered peripheral pressure were all dependent upon the hyperfunctioning of the adrenal gland. Further, it has been repeatedly noted that a pulse which before operation could not be palpated, has post-operatively re-appeared in the arteries, which is additional proof that they were in a state of spasm. The real proof of my contention is indeed to be noted when one sees a patient with definite gangrene of the fingers or foot and in excruciating pain in whom immediately after epinephrectomy, the gangrene stops advancing, the extremity becomes pink, the dead tissues slough away, the pain stops and he is able to get around with an extremity which had previously been condemned to amputation.

It appears to me in stating the above clinical facts that my contention has been sufficiently justified and that the correctness of my hypothesis has been proven as far as is possible, that the basis of these instances of spontaneous gangrene or Buerger's disease is beyond any reasonable doubt, due to an hyperadrenalinemia. The actual proof, of course, can only be ascertained by the isolation, detection and quantitative estimation of the amount of adrenalin in the blood.

It is a most difficult task to determine the presence of the hormones in the human blood of any one suffering from an hyperfunction of any of the glands of internal secretion. The method employed by my assistants, Doctor Achutin and Doctor Ornatsky, in overcoming this difficulty, is as follows: the blood to be examined is used on an isolated (method of Magnus) knot of gut of a cat, upon which the blood of any healthy animal such as a rabbit, or of a normal man, causes a convulsive abridgment (curtailment) followed by paralysis, while the blood of a patient suffering from hyperadrenal arteriosis or the blood of a patient suffering from Raynaud's disease or the blood of a rabbit artificially adrenalized, provokes a spasm in the gut and does not paralyze it. In other words, the gut continues the abridgment (curtailment) even sometimes in the presence of an increased tonus. It is interesting to note that a similar phenomena is provoked with the blood of a man in good health into whom adrenalin has been injected and vice versa, the blood of an epinephrectomized patient gives the same reaction as that of a man in good health. It is to be hoped that a more definite quantitative method for analysis may be evolved eventually so that even more definite proof can be given of my theory.

Assuming, therefore, that I am correct in my inferences and deductions as based upon the above experimental and practical results, it seems proper to place both hyperadrenal arteriosis and Raynaud's disease in the same category. There are two substantial distinctions, however, to be made between the two

of proliferation with the projection of papillary processes into the lumens. (See Figs. 7 and 8.)

Summarizing the pathological findings, the material removed at operation consisted of most of the greater omentum with very little fatty tissue remaining. There were many small and large cysts. Between these cysts the tissue was either soft, containing many tiny spaces and appearing like the rather soft lymphangiomas of the skin, or the intercystic tissue was somewhat firmer and œdematous. The histological examination of this last tissue disclosed

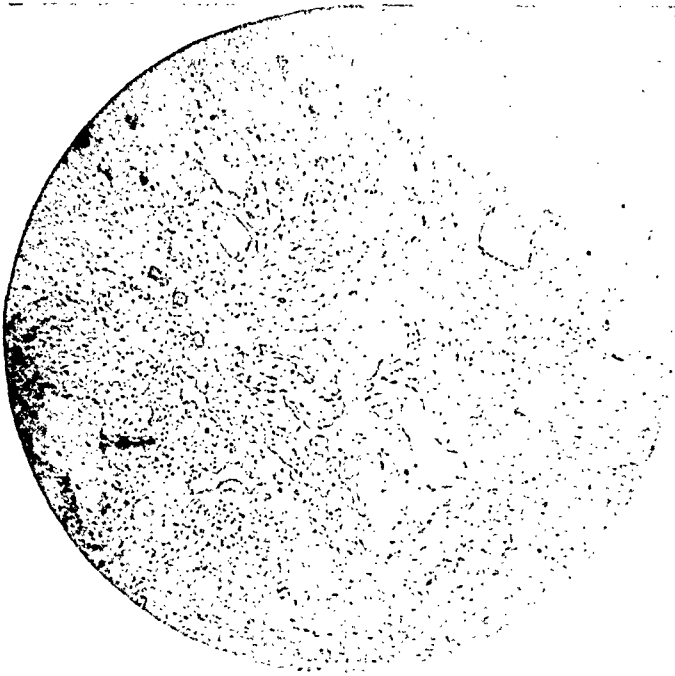


FIG. 5.—The formation of branching lymph vessels in the undifferentiated mesenchyme.

a marked development of new lymphatic channels from what appeared to be a rather indifferent mesenchymal tissue. From these microscopical channels definite stages of lymph channel enlargement were traced. As these channels enlarged, evidences of hypertrophy and hyperplasia of the lining endothelium were recognizable. Where the cysts became very large, the lining endothelium either became flattened or entirely lost. Just beneath the endothelial lining,

particularly of the smaller and medium-sized cysts, diffuse lymphoid infiltration was seen producing definite lymph follicles in some places. The pre-formed lymph vessels of the greater omentum were also dilated, due to obstruction of the efferent channels.

*Discussion.*—We believe that this case is one of a true tumor of the lymphatics of the greater omentum with certain secondary and obstructive changes that led to its final multicystic form. Although tumors of the lymphatics are divided into simple, cavernous and cystic lymphangiomas, according to their gross and microscopical appearance, genetically they have a common origin. The pathological divisions are not very sharp, for there may be transitions from one group to another. The consensus of opinion at present is that all these angiomas are true tumors of the lymphatic vessels, though some features may be attributed to stasis.

Simple lymphangiomas arise from the lymph spaces and lymph vessels and as a rule they are arranged in an anastomotic network. Cavernous lymphangiomas consist of a framework of connective tissue supporting numerous single and communicating grossly visible cysts filled with lymph.

conditions in that the hyperadrenal arteriosis occurs chiefly in the male while Raynaud's disease is more ordinarily noted in the female. The second is that in the arteries in hyperadrenal arteriosis thrombi are formed while in Raynaud's disease they do not become thrombosed. Furthermore, in the former condition, the arteries of the lower extremities are first affected but in Raynaud's disease in many instances the upper extremities are involved, although in both conditions the general arterial system is affected. It is certainly difficult to explain why this condition reacts differently on the different sexes and may possibly find its explanation in the influence of the sex hormones. The fact, however, I feel sure remains that both diseases are due to an hyperadrenalinemia.

For the relief of Raynaud's disease, I am also employing epinephrectomy with satisfactory results, in that where before operation the extremities were cold and bluish-black, within one or two days post-operative they became warm and pinkish. The pains in the extremities disappear and the patients are able to resume their occupations. I recall that Doctor Brown of the Mayo Clinic has obtained satisfactory results in these cases by lumbar sympathectomy and in Russia several surgeons like Shamoff and Abrajeno have obtained satisfactory results after Leriche's operation. Indeed, Leriche, in his last publication, states that epinephrectomy has given results in these cases where his operation of peripheral arterial sympathectomy has been ineffectual. I have performed personally, at least ten lumbar sympathectomies and can confirm Doctor Brown's results that the temperature of the extremities increases and that the condition is certainly improved. This is quite conceivable in that by this operation the sympathetic system is interrupted, removing the inhibiting influences on the arterial musculature and allowing them to dilate. In, however, performing epinephrectomy, I endeavor to accomplish the same result, but for the entire body and for all extremities as well as for the internal organs and it has been noted very strikingly that in patients with Raynaud's disease there is a definite leveling of the functions of the heart, it being reduced in size where previously it was dilated and the entire tone becoming more distinctive, similar observations having been noted in instances of hyperadrenal arteriosis.

It is apparent that as the result of these observations the *modus operandi* of the condition of spontaneous gangrene would seem best accounted for by the hypothesis of hyperadrenalinemia irritating the sympathetic nervous system with resultant spasm of the arteries and the consequent pathology.

It is to be hoped that my view may be confirmed by American surgeons and that they will employ in instances of spontaneous gangrene the uncomplicated and apparently efficient operation of epinephrectomy.

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NOTE: The reader is referred to page 959, for a communication from Dr. J. M. Rogoff of the Experimental Laboratory of Medicine, Western Reserve University, Cleveland, Ohio, entitled "A Critique on Estimation of Adrenalin in the Blood," for a valuable side-light on this important subject.

THE VASCULAR PROPERTIES OF TRAUMATIZED AND  
LAKED BLOODS AND OF BLOOD FROM  
TRAUMATIZED LIMBS\*

By DALLAS B. PHEMISTER, M.D.

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IF THE circulation to a limb is obstructed its arterioles and capillaries dilate. On release of the obstruction, reactive hyperæmia follows, lasting about as long as the obstruction, during which time the limb is flushed and increased in volume and the arterial limb pressure is lowered. It occurs equally well whether the limb is innervated or denervated. What causes this vasodilatation? Anrep, Lewis and Grant have assumed that a vasodilator metabolite—histamine or a histamine-like substance—is formed in the asphyxiated tissues during the period of hyperæmia. This substance is either destroyed *in situ* or washed away in the venous blood. To test such blood for vasodilator action, use was made of Anrep's viviperfusion apparatus. This consists of a flask attached to a cannular system which can be inserted in the course of an artery. The flask can be shortcircuited by means of a T bone-tap, emptied and filled, and its contents then circulated by again adjusting the tap. The apparatus was inserted in the course of the femoral artery of a dog and permitted of recirculation of blood collected from the femoral vein during the period of hyperæmia after recovery of the limb from the effects of the obstruction. The dog was anæsthetized with ether and the limb was denervated to exclude nervous influences, so that the changes observed must be explained on a physical or chemical basis; 0.4 of a gram of heparin was injected to prevent coagulation of blood and the perfusion apparatus was inserted in the course of the femoral artery just below Poupart's ligament. For the collection of venous blood either a Y cannula or a second perfusion apparatus with flask was inserted in the course of the femoral vein. A plethysmograph was applied to the limb for measuring limb volume, a mercury manometer was connected with the cannula in the femoral artery and another with a cannula in the carotid artery. Limb volume, limb pressure and carotid pressure were recorded on a long paper kymograph. The results of certain experiments with this method were reported by Phemister and Handy (*The Journal of Physiology*, 1927, vol. lxiv, p. 155). It was found that the circulation of the nontraumatized (unshaken) blood collected from the femoral vein of the limb during the period of hyperæmia caused no vasodilatation; that is, if a vasodilator substance is formed in the tissues during the period of obstruction it is not washed out by the blood to an extent which makes its presence demonstrable by this method. Ordinary venous blood behaves likewise.

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\* Read before the American Surgical Association, May 14, 1927.

If either arterial or venous blood flowing through the flask is shortcircuited for a period up to four or five minutes and the stagnant blood then sent through the limb (in case of venous blood the flask with its tubes clamped off must be transferred to the arterial side), it causes either no vascular changes or the changes are very slight. If either arterial or venous blood is withdrawn and shaken for a few seconds to a few minutes before insertion into the flask, it produces vasodilatation on circulation. If either arterial or venous blood is shortcircuited in a flask containing a bead, the inlet and outlet tubes clamped and the flask detached and shaken without exposure to either air or light, it produces vasodilatation. Arterial or venous blood, the gaseous content of which has been modified by exhaustion of gases and recharging with varying quantities of  $O_2$  or  $CO_2$ , always caused vasodilatation. However, the blood was always traumatized in making the modification.

The longer the traumatism the greater the vasodilatation up to a certain point. The maximum effect from shaking is reached in two to three minutes, beyond which shaking for as long as ten minutes produces no increase.

What change comes about in the blood as a result of this amount of traumatism that gives it this vasodilator property? Have vasoconstrictor substances been destroyed, or has a vasodilator substance been liberated or created from blood elements? The two vasoconstrictor hormones, adrenalin and pituitrin, are far too stable from chemical standpoints to be destroyed by such slight traumatism as is necessary to give the reaction, and when blood has been traumatized to a point where it gives a maximum dilator action it is necessary to add at least five times as much adrenalin or pituitrin as is necessary to give vasoconstriction in order to obliterate this vasodilator effect.

Is a vasodilator substance liberated or created by traumatizing the blood elements? When blood is shaken for two to three minutes which is enough to produce a maximum vasodilator effect, the pH remains constant or practically so; consequently, the reaction is not the result of change in the acid-base balance.

Is histamine or a histamine-like vasodilator substance liberated from the blood cells by breaking them up? If so, the greater the amount of traumatism the greater the amount of such substance liberated and the greater should be the vasodilator effect. Laking, or hæmolysis of blood by freezing and thawing, breaks down nearly all of the cells and should most effectively liberate the vasodilator substance. Also, the greater the amount of traumatized blood circulated the greater should be the vasodilator effect. Consequently, quantitative tests were made by the circulation of different amounts of blood traumatized for varying lengths of time, of laked blood and of blood to which different amounts of histamine were added. When more than 75 c.c. were used, blood was added from another dog to keep blood volume up to normal. It was found that the greater the amount of histamine added to a given quantity of blood and the greater the quantity of histaminized blood circulated the more marked the vasodilator effect. With large amounts of histaminized blood entering the animal there was an initial increase in limb volume, fall



in limb pressure and then fall in general blood-pressure. But after one to one and a half minutes both limb and general vascular beds would acquire the power of resisting much of the histamine action, although when 500 c.c. of blood were used the histamine would continue to enter the circulation in much the same concentration for three and a half to four minutes.

The quantitative tests with traumatized blood were made as follows: Blood was traumatized by shaking for a few seconds to one hour and the effects were determined of circulating amounts varying from 30 to 475 c.c., as previously stated. When 30 c.c. were used the maximum vasodilatation was produced by shaking for two to three minutes; prolongation of the act for ten or twelve minutes producing no alteration in the effect; but shaking for twenty minutes caused vasodilatation followed by vasoconstriction, and shaking for forty to sixty minutes caused vasoconstriction from the beginning, which lasted for three to five minutes, after which vascular response was very much diminished.

Increase in amount of slightly traumatized blood circulated did not increase proportionately the vasodilator effect. Thus 30 c.c. of blood shaken for two or three minutes cause vasodilatation, which reached its maximum in twenty to twenty-five seconds and disappeared in fifty to seventy seconds; 75 c.c. produced slightly more effect than did 30 c.c., but 220 or 475 c.c. produced no greater effect than did 75 c.c.; 475 c.c. of blood traumatized for two to five minutes caused a maximum dilatation in thirty to thirty-five seconds, which wore off in sixty to ninety seconds despite the fact that undiluted traumatized blood was still going through the limb; however, when 475 c.c. of blood shaken in 50-c.c. lots for one hour were circulated there was limb constriction lasting for eight minutes followed by slow recovery.

Thus blood that had been slightly traumatized caused vasodilatation lasting a short time, and increase in the quantity of blood circulated beyond approximately 75 c.c. did not increase the duration of the vasodilatation; blood that had been traumatized extensively, as by shaking for twenty minutes, caused vasodilatation followed by vasoconstriction, and blood traumatized very severely, as by shaking for one hour, caused vasoconstriction only. The greater the quantity of severely traumatized blood circulated, the longer the duration of the vasoconstriction.

Quantitative tests were made with laked blood, which was prepared by freezing with liquid oxygen and thawing. Amounts were circulated varying from 1 minim to 220 c.c. One to 10 minims injected into the tube caused vasodilatation, which increased with increase in the amount of blood injected; but 1 c.c. caused beginning limb dilatation followed by limb constriction and 10 c.c. or more caused limb constriction only, and the greater the amount the longer the constriction lasted.

When untraumatized blood is treated with very small amounts of laked blood it produces vasodilatation on circulation, but as much as 5 to 10 per cent. produces beginning vasodilatation, followed by limb constriction and larger percentages cause limb constriction only.

Since blood traumatized in varying degrees acted similarly to blood that had been laked in varying degrees, it was thought probable that their action was produced by the same thing and that traumatism had produced hæmolysis. Consequently, blood that had been shaken for lengths of time varying from a few seconds to one hour was centrifuged and the plasma examined for the presence of hæmoglobin. It was found to be present in amounts that varied directly with the amount of traumatism, ranging roughly from 0.0573 gm. per 100 c.c. for blood shaken for thirty seconds to 3.689 gm. per 100 c.c., or over 20 per cent. of the total hæmoglobin for blood shaken for fifty-five minutes. Microscopic examination also showed evidences of breaking down of red cells. Consequently, the hæmolysis is responsible for the vasomotor properties of both traumatized and laked bloods.

The facts that small amounts of hæmolyzed blood or of traumatized blood caused vasodilatation and fall in regional blood-pressure when circulated through the limb raised the question as to their effect when injected into the general circulation. To determine this point, 475 c.c. of blood shaken for four or five minutes, or to which 5 to 10 c.c. of hæmolyzed blood were added, were circulated from a flask connected with the femoral vein. In none of several experiments was there any considerable amount of alteration in general arterial blood-pressure. It was thought possible that the immediate reactions from indirect blood transfusion in man might be due to the traumatism resulting from mixing with the sodium citrate solution; but the absence of any considerable fall in general blood-pressure when traumatized blood was inserted into the general circulation in dogs argues against that view.

Traumatic shock has been regarded by many investigators as due to a toxic substance derived from the traumatized tissues entering the general circulation and producing vasodilatation with resultant low blood-pressure. It might even be conjectured that a vasodilator substance is absorbed from the damaged extravasated blood in quantities sufficient to produce a state of shock.

A test for the presence of vasodilator substances in the blood from a traumatized limb was made in the following way: A viviperfusion apparatus was inserted into the femoral vein of a dog, a constrictor was applied distally and the limb was severely hammered. A second animal was prepared in the usual way with a viviperfusion apparatus in the femoral artery and a plethysmograph on the limb. Carotid blood-pressure tracing was then established for the first dog and the constrictor removed. The limb swelled rapidly afterward and the animal's blood-pressure gradually fell in the course of a few minutes to one hour to the level of 80 to 50 mm. of Hg., which is within the range of that ordinarily encountered in traumatic shock. The venous blood flowing through the flask was then shortcircuited, the connecting tubes clamped, the flask detached and connected with the artery of the second dog without traumatizing blood in the transfer. Circulation of such blood several times in three experiments usually caused very little or no vasodilatation; but if the blood was withdrawn from the flask and shaken for a short time it produced the usual vasodilator reaction. Therefore, if there is a vasodilator

substance in the blood coming from the traumatized limb of an animal which produces shock, it is not present in sufficient quantity to be detected by this method.

The experiment does not support the theory that shock is a traumatic toxemia from a histamine-like substance formed in the traumatized tissues and causing vasodilatation of the general capillary bed. Furthermore, necropsy examination of the traumatized limb showed increase in limb volume from hemorrhage which was sufficient to account for the fall in blood-pressure. In fact, the volume of blood that it was necessary to withdraw intermittently in the course of an hour in order to kill an animal was always less than the increase in volume of the traumatized limb of the other animal, which was due very largely to hemorrhage in the tissues.

The nature of the substance or substances liberated by traumatizing or laking the blood which produce the vascular changes here recorded have not been determined, but they appear to be the same in both cases. They are rendered active by the hæmolysis. The vasodilatation which results from a small amount of hæmolysis may be due to one factor, and the vasoconstriction which results from a large amount of hæmolysis may be due to another factor, or they may both be due to the same thing acting in different concentrations. The quantitative tests speak against the action being the result of histamine or a histamine-like substance.

No definite clinical phenomena can at present be explained by these reactions. But since such marked vasodilator properties can be created in the blood by mild injury and slight hæmolysis, it is not unreasonable to assume that these properties may be acquired in certain cases of injury or disease and that they may be responsible for certain unexplained circulatory symptoms.

# SPINA BIFIDA AND CRANIAL MENINGOCELE \*

By THOMAS A. SHALLOW, M.D.  
OF PHILADELPHIA, PA.

IN PRESENTING the subject of spina bifida and cranial cephalocele, a topic which is so intimately associated with the names of Von Bergman, Von Recklinghausen, Hildebrand and Frazier, one must hesitate before he attempts to add to the extensive study and the work done by these men. We are presenting these cases out of a series of sixty patients which have been observed in the J. Chalmers DaCosta Clinic of the Jefferson Hospital in which the question of operation arose. Spina bifida is a congenital malformation of the vertebral column. It is

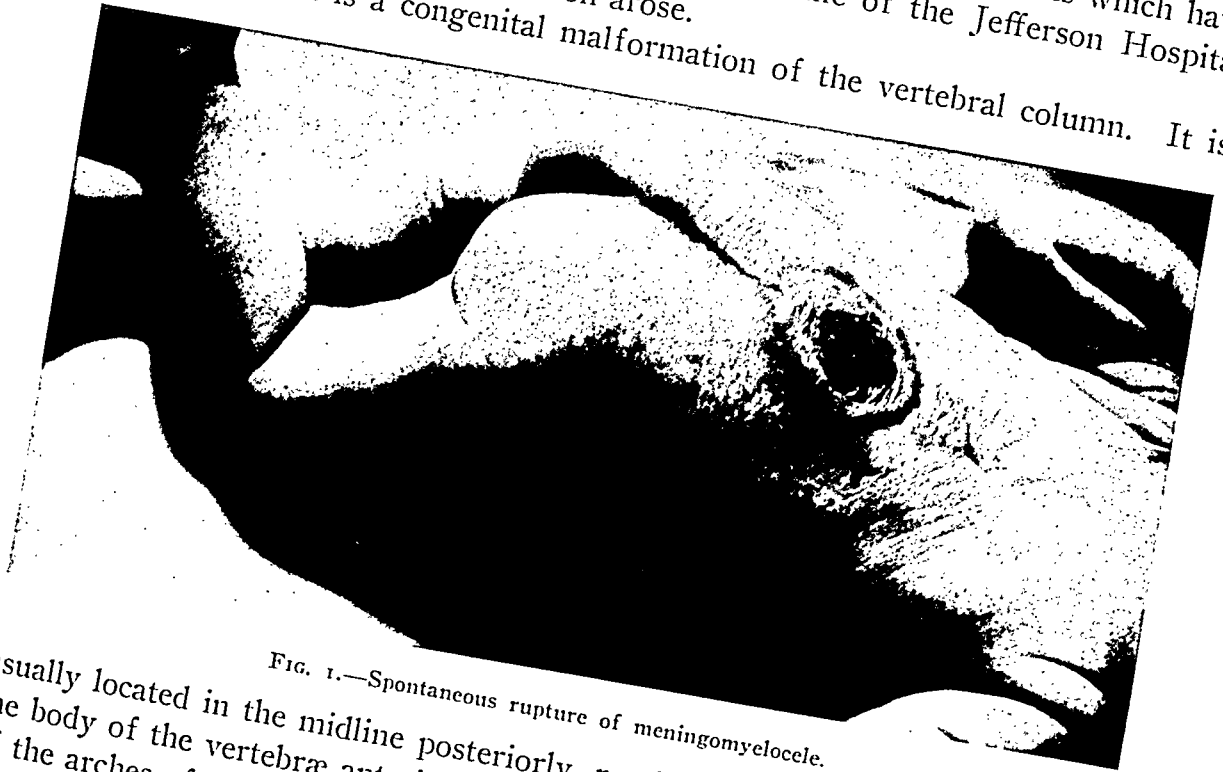


FIG. 1.—Spontaneous rupture of meningocele.

usually located in the midline posteriorly, rarely the defect is found through the body of the vertebræ anteriorly. It varies from an arrested development of the arches of the vertebra to a complete absence of these structures. It is associated with a protrusion (known as a sac), usually in the midline and distended by cerebrospinal fluid. The contents of a sac may be cerebrospinal fluid alone, cerebrospinal fluid and cord or the cauda equina.

There are four common types of spina bifida. (1) Spinal meningocele, (2) meningocele, (3) syringomyelocele, (4) spina bifida occulta. (1) In a spinal meningocele, the simplest of these four types, the skin is usually sound over the entire sac. The dura and arachnoid may form the second and first layers of the wall of the sac, or the arachnoid alone may be present in the wall, the dura being present only at the neck of the sac. In meningocele the cord and nerves remain in the spinal canal.

\* Read before the Philadelphia Academy of Surgery, January 16, 1928.

(2) In a meningocele, the type which we have most frequently encountered, the skin was not sound in any of our cases. The dural layer was observed in one of several positions: (a) The dura was a simple cleft, remaining in the spinal canal and the sac protruding through the cleft. (b) The dura was cleft and blended with the fascia of the erector spinæ mass muscles. (c) The dura extended upward as a cuff and surrounded the



FIG. 2.—Showing defective development of 6-7-8-9-10 thoracic vertebræ—same patient as Fig. 1.

neck of the sack for about an inch. The spinal cord or the cauda equina was found adherent to the arachnoid and the cerebrospinal fluid was in front of the nerve structures which were spread out and intimately blended with the posterior wall of the sac. In some cases the sac contained, in addition to the cauda equina or cord, nerve roots which passed from the spinal cord into the sac and then reentered the spinal canal. In this type of case we found that there was a partial arrest of development of the nervous elements of the cord.

(3) Syringomyelocele. In this type we found that the central canal of the cord contained cerebrospinal fluid. The rest

of the cord was spread out over the distended central canal. Both of these structures, cord and distended canal, passed through a dural defect.

(4) In the type known as spina bifida occulta, there is a spinal defect, discovered by touch and X-rays, which is covered with sound skin. Sometimes the spinal defect is marked by a depression of the skin. The cleft, in the occult form, is occupied by blended membranes adherent to skin and cord.† There is often a superabundance of hair over the lesion and tumor formation is common.

The etiology of such anomalies is failure of mesenchymal fusion. From the mesenchyme are derived the muscles of the back, the bones and ligaments

† Spencer and Gask, 1910, Blakiston & Son.

## SPINA BIFIDA AND CRANIAL MENINGOCELE

of the vertebral column and the meninges. That developmental arrest is the only cause of these anomalies is doubtful. Spencer and Frazier both emphasize the possibility of an excess of cerebrospinal fluid being a factor. In confirmation of this view we have seen spina bifida associated with hydrocephalus and hydrocephalus follow operations for spina bifida, and we have in our series observed hydrocephalus follow a spontaneous rupture of the sac. (Case II.)

### *The Signs and Symptoms of Spina Bifida.*—

There is a globular or oval swelling which is usually translucent to light. It increases in size on coughing or crying and may or may not pulsate. Occasionally we are able to partially reduce the swelling. A gradual increase in the size of the swelling occurs and in the course of a number of weeks or months ulceration of the skin takes place, rupture of the sac occurs and meningitis usually arises.

The external appearance of the sac gives us definite diagnostic and prognostic information. When the outer covering of the sac is made up of sound skin the diagnosis lies between simple meningocele and syringomyelocele. In these two types of cases there is complete development of the cord and the cutaneous covering, which make them the most favorable types of cases for surgical intervention.

In contrast to the sound skin of the meningocele and syringomyelocele, the outer covering of the meningocele presents an entirely different aspect. It is made up of three zones, the dermatic, the serous and the medullary zones. The medullary zone forms the outer covering of the sac and is made up of pia mater and the unclosed portion of the neural tube. It is this zone which must be preserved in its entirety at the operation and replaced in the spinal canal; otherwise irreparable damage is inflicted on the nerve structures attached to this zone.

In our series of cases operated upon and the studies made on the cases that were not operated upon, we have found meningocele the most common form. In this type there is a partial arrest of development of nerve



FIG. 3.—Wide separation of cranial bones after spontaneous rupture of spina bifida.

structure as well as the mesenchymal defect. The nerve structures and pia mater are adherent to the summit of the sac. As the sac increases in size, traction is exerted on the nerve structures lessening their nutrition and impairing their function. Aside from the question of elongation of the nerve elements, the destructive influence of the fluid pressure on the nerves at the neck of the sac as they emerge from the spinal canal must be considered.\*

It is because of these factors, the elongation of the nerves with their subsequent destruction or partial destruction, the damage done by the fluid



FIG. 4.—Spina bifida associated with hydrocephalus.

pressure on these nerves from within, and the almost certainty of ulceration and secondary meningitis of the vast majority of these cases we are making our plea for early operation.

*The Question of Operation.*—In recommending operation on these deformities we must take into consideration: 1. The degree of arrest in development of the nerve structures. 2. The damage due to the nerves or the cord after birth. 3. The possibility of hydrocephalus following these operations. 4. The presence of ulceration or infection of the cutaneous wall.

The presence of hydrocephalus associated with spina bifida forbids operation. Incontinence of urine and feces or the presence of gross deformities, such as, flaccidity of the lower extremities (Paraplegia), also forbids operation. It is of interest that in Case II, a child showing flaccidity of the lower extremities, with reactions of degeneration in all the muscles of those extremities, to find that after a spontaneous rupture of the sac, tone appeared in these muscles and there were slight movements on irritation of the plantar surfaces; a fact which indicates that pressure upon and the elongation of the nerves by the increase in the size of the sac and by increase in the amount of fluid explain some of these phenomena.

\* These developmental defects occur at a time in fetal life when the spinal cord is the same length as the spinal column. With the growth of the vertebræ the cord apparently ascends consequently in syringomyelocele and meningocele the nerve structures which are fixed outside of the spinal canal are stretched and distorted and their function impaired.

# CYSTIC LYMPHANGIOMA OF THE GREATER OMENTUM

FIG. 6.—Showing the progressive dilatation of the newly formed lymphatic channels.

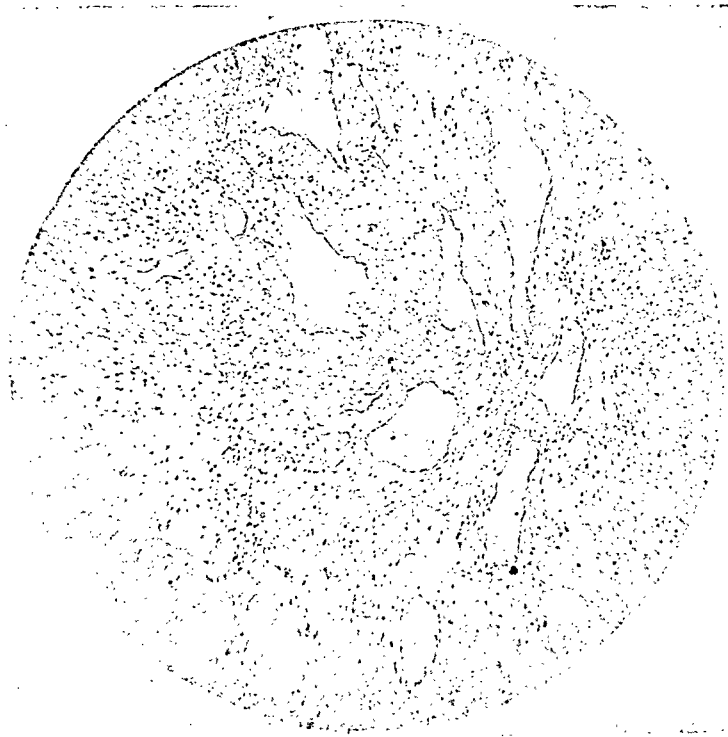
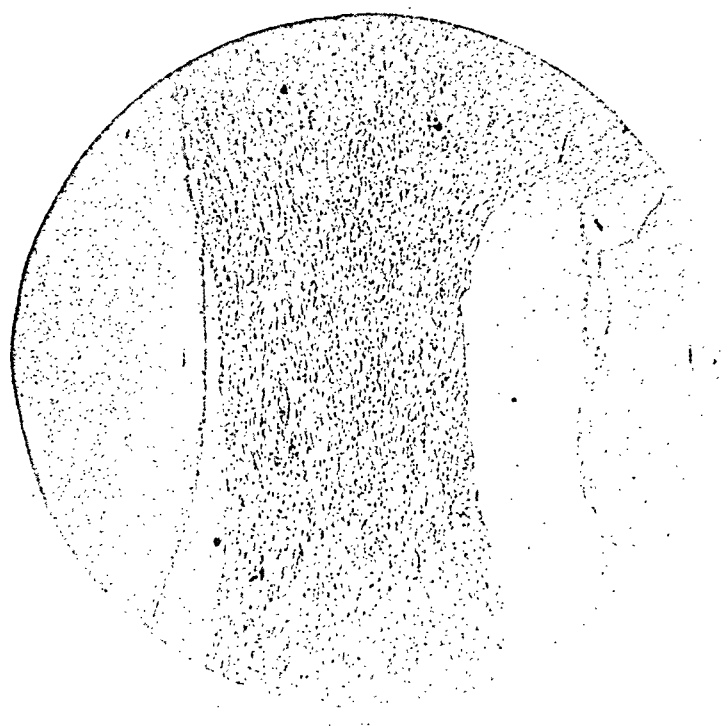


FIG. 7.—A large cyst lined by flattened endothelium.





## SPINA BIFIDA AND CRANIAL MENINGOCELE

In Case V of this series, an infant referred by Dr. P. B. Bland, showed a spina bifida, also a defect in the muscles of the posterior abdominal wall, an opening into the interior of the bowel, and an intussusception of the entire large intestine and the appendix protruding out of the cleft adjacent to a spina bifida.

The mere presence of club feet, paralysis or atrophy of a group of muscles, should not contraindicate operation. Case XI, age eight months, was observed in our Clinic for one year. In this case the skin over the sac was sound and when the child was first seen, at eight months of age, the swelling was about the size of a tangerine orange. Examination of the extremities showed loss of muscle tone but no paralysis in either leg. The child reported at three

month intervals for examination. At the end of the sixth month, when the child was fourteen months of age, the swelling had increased in size. The muscles of the legs were atrophied and power was lessened. At that time we tried to persuade the mother to have the child operated upon, but without avail. At the end of another six months, the

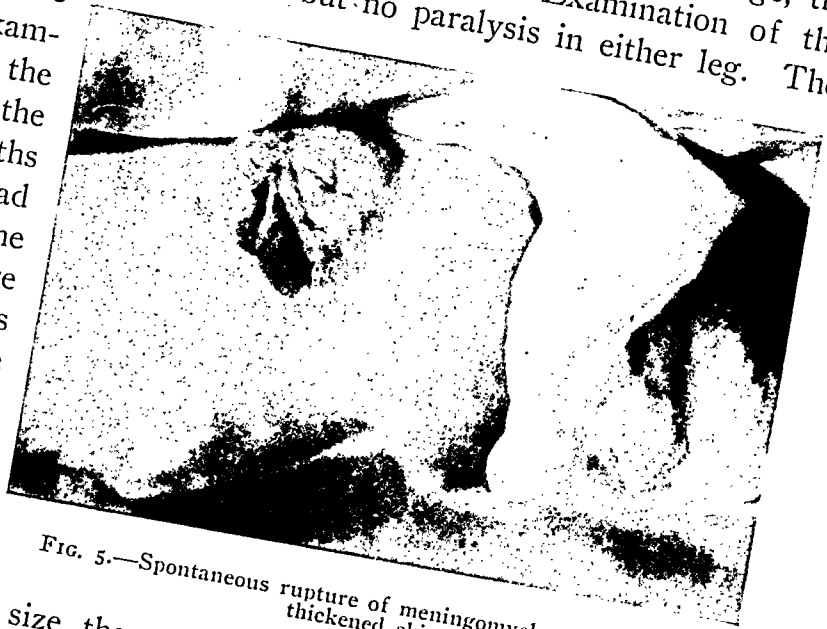


FIG. 5.—Spontaneous rupture of meningocele—note the thickened skin.

sac was greatly increased in size, there was almost complete loss of power in the left leg and decidedly more weakness in the right leg. The mother now gave her consent to the operation. He crawled about the floor six months after the operation. One year after the operation he was able to stand and is now able to walk a few steps. His mother states he has control of the bowels except when he has diarrhoea. He does not have control of the bladder at night but does during the day.

This case is of interest because it shows the damage which occurs to the nerve structures because of elongation due to enlargement of the sac and the fluid pressure within the sac; a conclusion verified by the history, by our observation and by the improvement following the operation. The delay in this case was due to the false feeling of security afforded by the sound skin over the sac.

This leads us to the question of the time for operation. In uncomplicated cases it can be expressed in a few words. Before the sac is obviously enlarging and before ulceration has occurred. Enlargement causes traction on the nerves; ulceration prohibits operation because of the practical certainty of meningitis resulting. Unless hydrocephalus is present the fear of it following operation should not be considered. It is a possibility. Meningitis or

nerve destruction is almost a certainty without operation, except in rare cases of spontaneous closures.

The treatment of spina bifida may be said to be the conversion of a congenital decompression of the spinal cord to a surgical decompression, or, when the dura is sutured, a closure of the gap.

*Operation.*—Position of the patient. The child was placed on the abdomen and a sand bag was laid beneath the hips in order to elevate the hips and to prevent an undue loss of cerebrospinal fluid during the operation. As a rule, with the patient in this position, the only fluid lost will be that from within the sac.



FIG. 6.—Spina bifida associated with bilateral club feet, fibrous ankylosis of both knees, and prolapsus of rectum.

An incision was made through the sound skin encircling the neck of the sac; bleeding was carefully controlled because young children stand loss of blood very badly. The neck of the sac was dissected out carefully, free of the muscles and fascia, down to the opening out from which neck of the sac protruded. The outer covering of sound skin, or in meningocele, the dermic, serous and medullary zones, remained as a cap over the distended sac which was now free at its neck. The cutaneous cap was then reflected backward by careful dissection of the skin from the arachnoid layer, extreme care being taken not to rupture the sac. Little difficulty was encountered during the separation until the medullary zone was

reached. At this point it was impossible to further separate the cap. An incision was made separating the medullary zone from the serous and dermatic zones. The medullary zone was left on the distended sac which was now composed of the medullary zone, the arachnoid and the nerve structures. The sac was then opened and collapsed, and care was taken not to permit any bleeding to take place into the collapsed sac. The collapsed sac was placed in the trough of the spinal canal. The question now arose whether the dura should be closed or whether it should be left open and a spinal decompression operation performed. It will be recalled that in the early description of these cases the dura was observed to have been in one of three places; first, there was a cleft in which all the dura remained in the spinal canal and the sac protruded through this opening. Second, the dura was extended through the bony structure upward along the neck of the sac as a cuff reaching about one-third the distance to the fundus. Third, the dura was cleft and blended with the erector spinæ mass group of muscles.

If there is a simple cleft of the dura the sac which consists of the collapsed membranes and nerve structures should be replaced in the spinal canal and the dura closed, or, if the dura extends upward as a cuff the collapsed sac and nerve structures should be replaced in the spinal canal and the dura

closed from within the sac, using enough of the dura in suturing to comfortably accommodate the collapsed sac and its nerve structures. If the dura is blended with the erector spinæ mass it will be impossible to obtain a sufficient amount of dura to make a closure over the collapsed sac. In this type of case a spinal decompression should be done, leaving the dura adherent to the muscle, and using the dura and muscle flap as a protection over the collapsed sac. As a matter of fact spinal decompression should be done on any of the cases if the redundant sac is so large that it precludes closure of the dura without serious encroachment on the nerve structures. The remainder of the operation should be performed either by the method of Babcock or Frazier.

*Post-operative.*—The child should be placed on the abdomen, the foot of the bed being elevated in order to prevent any leakage of cerebrospinal fluid. In spite of this precaution we had in two of our cases a small temporary leak lasting for several days.



FIG. 7.—Spina bifida associated with intussuscepted bowel through a defect in the posterior abdominal wall.

*Conclusions.*—Cases of spinal and cranial defect do not require extensive repair to prevent recurrence. Operation should be performed early in life before ulceration of the sac has occurred and before there has been any decided increase in the size of the sac. We have satisfied ourselves that increase in the size of the sac, especially in meningocele, causes degenerative changes in the nerve elements because of traction and malnutrition. Cranial defects are due to unequal development of the cranial bones.

Hydrocephalus associated with spina bifida precludes operation, but the possibility that hydrocephalus might develop after operation should not prove prohibitory.

Paraplegia of the lower extremities, paralytic club feet, incontinence of urine and feces, and gross visceral defects also contraindicate operation.

*CASE REPORTS.*—CASE II.—D. C., female, age one month, referred to the DaCosta Clinic by Doctor Bauer. On admission a lumbar meningocele was observed. X-ray examination: A spinal defect involving lower lumbar region was reported. On the date of admission there was some ulceration of the sac. The legs were flaccid—reflexes were absent. Neurological examination showed reaction of degeneration in both extremities. Hydrocephalus was not present.

Two days after admission to the ward the sac collapsed. (Fig. 1.) It will be seen from this picture, taken one week after the collapse, that there has been some restoration of function to the muscles of the right leg. This fact was borne out by examination of

Fig. 9.—Same patient one month after operation.

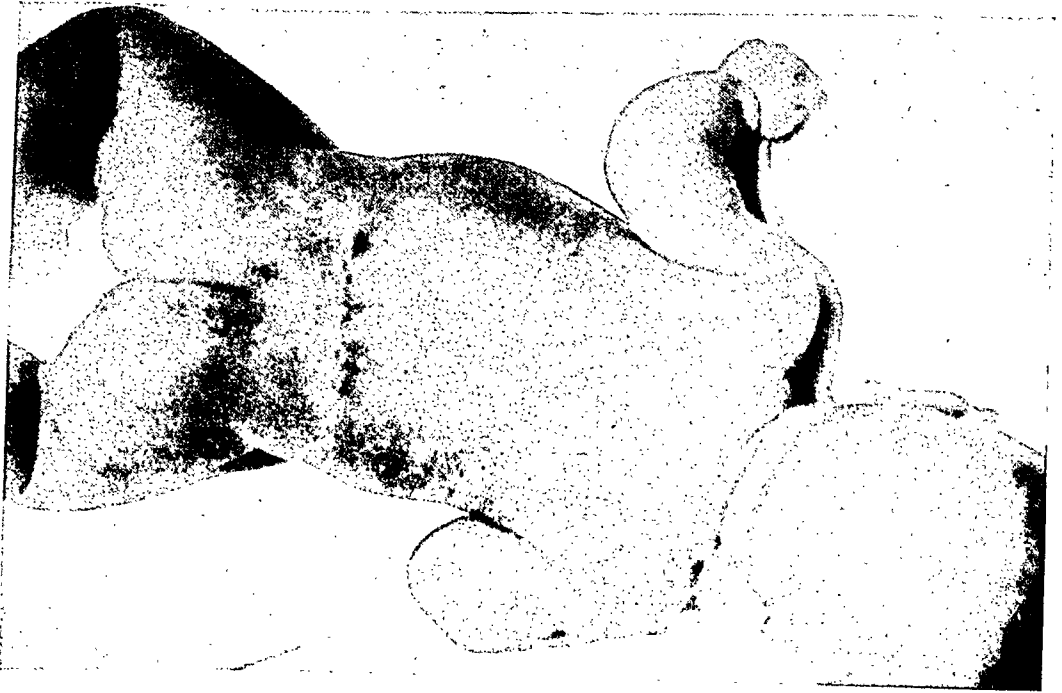


Fig. 8.—Spina bifida—meningomyelocele.



THOMAS A. SHALLOW

## SPINA BIFIDA AND CRANIAL MENINGOCELE

the extremities. There was a return of muscle tone, and on irritation of the plantar fascia a slight movement of the right foot. Further examination disclosed a defect in arches 6-7-8-9-10 thoracic vertebræ. (Fig. 2.)

Two weeks after the spontaneous rupture of the sac it was noticed that the head was beginning to enlarge. This increase in size was not very noticeable during the first week. The second and third weeks the head was decidedly enlarged. There was wide separation of all the bones of the vault of the skull. (Fig. 3.) There was no return of the sac at this time or at any time up to the death of the child, six weeks after admission.

This case teaches us because of the spontaneous rupture of the sac there was some restoration of function in the legs, therefore, the presence of the sac, either by reason of traction on the nerve elements or fluid pressure on the nerve structures, causes a destructive change to take place in the spinal cord, cauda equina or spinal nerve. Is it not more reasonable to arrest this process of nerve destruction by early operation than to permit it to persist and cause irreparable damage?

This case also demonstrates the association of spina bifida occulta with true spina bifida; and lastly, the enormous increase in pressure manifested by the hydrocephalus (Fig. 3) did not cause a return of the sac which had not been surgically repaired.

CASE III.—H. C., female, eight weeks old. (Fig. 4.) Showing the presence of hydrocephalus associated with meningocele. This case was observed in the Clinic for three weeks, the lumbar sac did not increase in proportion to the size of the head. The presence of hydrocephalus contraindicates operation on the spina bifida.

CASE IV.—M. B., male, age two months. At birth a sac was present about the size of an orange. One week after birth the sac collapsed.

Figure 5, taken seven weeks after the spontaneous rupture shows no evidence of recurrence. The protrusion does not contain fluid, it is made up of thickened indurated skin.

In this case the associated deformities of club feet, fibrous ankylosis of knees and prolapse of anal mucous membrane are present. (Fig. 6.) Three months after the discharge of the patient from the hospital, there was no evidence of recurrence of the sac. This child was not operated upon.

CASE V.—B. C., female, one week old, was seen by us on the service of Dr. P. B. Bland. (Fig. 7.)

There was lumbo-sacral meningocele present. In addition a defect in the lumbar muscles and the posterior part of the sigmoid. The mass protruding in the large bowel intussuscepted through the bowel and muscle defect. This mass was reducible. The child died one week after birth. No operation was done.

CASE VI.—M. Q., female, age three months. History No. P-11169. Transferred from the service of Doctor Bauer.

X-ray examination disclosed a defective first lumbar vertebra. (Fig. 8.) On inspection of the sac the zona medulovascular was present (Meningocele). No deformities of the extremities were present, no incontinence of urine or feces, no evidence of hydrocephalus. Operation.—Performed April 30, 1927, as described. Healing was by first intention. The child was discharged on May 30, 1927, in excellent condition. Progress.—Figure 9 shows appearance of back one month after operation. Report of January 24, 1928 (nine months after operation). There has been no evidence of recur-



FIG. 10.—Skin and part of the cerebellum from cranial encephalocele.

rence of deformity. She has not been sick a day. She is able to stand and walk a few steps without assistance.

CASE VII.—F. G., female, age two months. History No. O-4445. Referred from the service of Dr. P. B. Bland on November 10, 1925. At birth there was noticed a swelling in the occipital region to the right of the midline. The sac increased on crying, was translucent to light. It was partially reducible and was about the size of a duck egg. Operation was performed November 12, 1925, by excision of the sac. The dura did not form any part of the sac but was adherent to the margin of the bone. The



FIG. 11.—Occipital encephalocele.

arachnoid was closed by a continuous catgut stitch. The defect in the bone would admit the tip of the index finger. It was to the right of the midline, between the foramen magnum and occipital protuberance. I believe the opening was the result of delayed development of the occipital bone on the right side. The opening was closed by fascia in which the periosteum adjacent to the opening was included in the bite of the needle. Four sutures were required to close the opening. The scalp was closed without drainage.

Progress.—Patient made an uninterrupted recovery. Sutures were removed from the scalp on the eighth day. Patient was discharged from the hospital, December 31, 1925. Report from the child's mother January 16, 1928 (child two years and four months of age). There has been no sign of return of the lump. She is bright, happy and normal in every way.

CASE VIII.—R. M., female, age two months. History No. P-4162. Referred to the Clinic by Doctor Bauer, November 23, 1926. There was a large sac to the left of the midline in the occipital region. The sac was not reducible, it increased in size when the child cried and it was not translucent to light. A distinct pulsation was present. A diagnosis of encephalocele was made. Operation December 4, 1926.—An incision was made encircling the base of the sac through the sound skin. The neck of the sac was exposed by careful dissection. The left lobe of the cerebellum was partially prolapsed through a defect in the occipital bone. The skin flap was reflected backward and separated from part of the cerebellum. At the fundus of the sac, the brain was so adherent. I resected part of the cerebellum with the skin cap. (Fig. 10.) Bleeding was controlled without difficulty. The bone defect was covered with a fascial flap, the sutures passing through the periosteum at the margin of the bony defect. The scalp was closed without drainage.

## SPINA BIFIDA AND CRANIAL MENINGOCELE

Progress.—That evening the child's temperature rose to 105, pulse 150. She died the following morning. December 5, 1926. Post-mortem examination showed that there was a twist to the left of the cerebral peduncle. Inspection of the bones of the skull: a foramen is noticed in the occipital bone to the left of the midline; the left temporal and the left part of the occipital bones are smaller than the right temporal and occipital bones. This finding would confirm our opinion that the cause of cranial defect is an unequal development of the cranial bones. The question of increased pressure of the cerebrospinal fluid does not seem to be as potent a factor in the production of cranial defects as some think it to be in the development of spinal anomalies.

CASE IX.—B. P., female, age one month. Referred from the service of Dr. P. B.

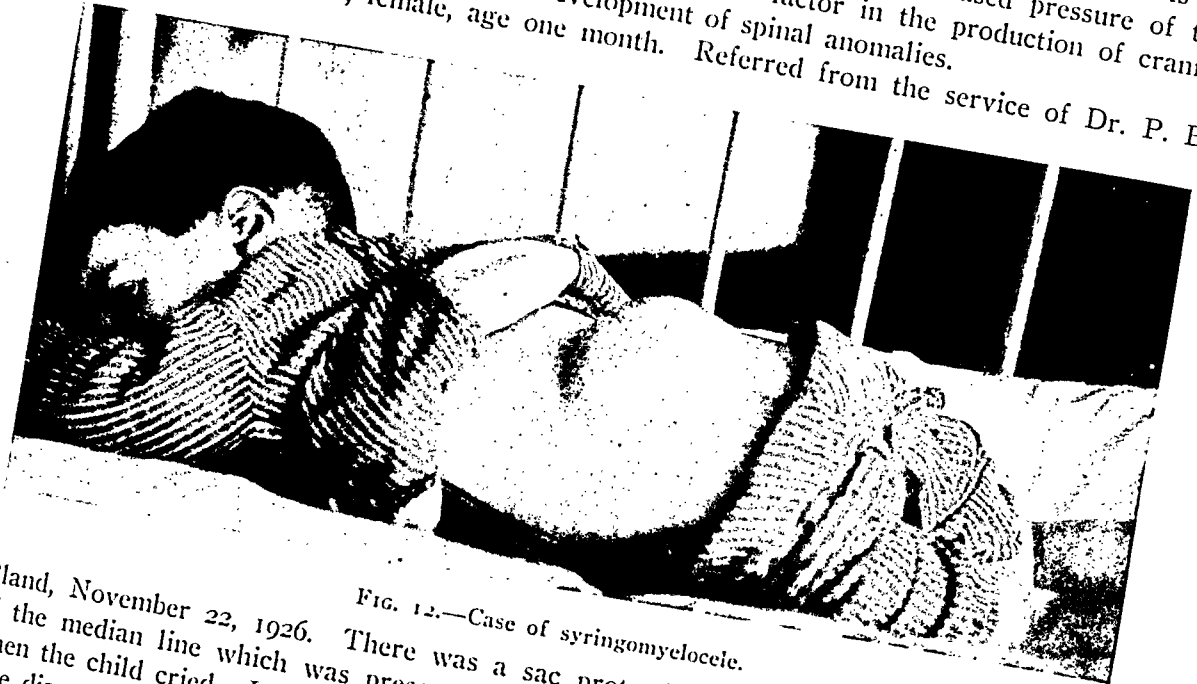


FIG. 12.—Case of syringomyelocele.

Bland, November 22, 1926. There was a sac protruding through the skull to the left of the median line which was present at birth. (Fig. 11.) The sac increased in size when the child cried. It was opaque to light and there was a distinct pulsation present. The diagnosis of encephalocele was made. Operation December 18, 1926.—It was found that the cerebellum was definitely adherent to the fundus of the sac, and was separated with some difficulty. Again the question of excision of part of the cerebellum, which had been done in previous cases, arose. We decided to replace the cerebellum in the cranial box. The arachnoid was sutured. The bony gap which was about one-half inch in diameter was covered with fascial flap. The scalp was closed without drainage. Progress.—The child made an uneventful recovery. Discharged from the hospital, December 31, 1926. We have not had a report on this child since April, 1927. The family changed their residence to another city. The last report of April was there was no evidence of a recurrence of the sac. The child appeared normal in every way.

CASE X.—M. P., female, age two months. History No. N-488. Admission through the dispensary on June 30, 1924. Examination disclosed a sac in the midline posteriorly in the occipital region which increased when the child cried—was partially reducible and did not pulsate. The skin over the sac was sound. Operation on July 2, 1924.—Excision of sac, closure of opening as described in the preceding case. Closure of the scalp without drainage. Report of January 13, 1928.—Three years after operation, there was no return of the sac. The child was extremely nervous when interviewed, appeared apprehensive and fearful. She had difficulty with her speech. Her general health was excellent.

CASE XI.—W. N., male, age two years. History No. N-3175. (Fig. 12.) At birth a small swelling was noticed in the midline posteriorly. It was observed by the mother that the baby seldom moved his feet, as time passed he did not attempt to walk. The left leg was thin and flaccid, the right leg had some muscle tone. When he was about a year old the tumor in the back began to enlarge. His mother noticed that he had less power in his legs. During the second year the sac greatly increased in size. Operation

April 17, 1926.—A syringomyelocoele was found. The nerve structures which included the lower portion of the spinal cord, in the centre of which there was a distinct sac, the remainder of the cord was stretched over the sac. The cord with the pia arachnoid were dissected from the skin. The dura surrounded the neck of the sac. The sac collapsed. Because of the redundant membranes and elongated nerve structures, it was impossible to close the dura. A spinal decompression was performed.

Progress.—There was some leakage of cerebrospinal fluid for several days after the operation. One month after the operation the child stood up in his crib. Report of January, 1928, there is no recurrence of the sac. A definite pulsation can be felt at the site of the old defect (spinal decompression). He is able to stand and walks with



FIG. 13.—One month after closure of syringomyelocoele.

assistance; he had control of his bowels, except when he has diarrhoea, but not of his bladder at night. He is bright and intelligent. There is no evidence of hydrocephalus.

CASE XII.—Helen S., female, age five months. History No. O-1246. At birth a sac was present at the third lumbar vertebra. The outer surface showed the zona medulovascularosa; it was not ulcerated nor was there any evidence of infection. Operation—September 9, 1925, by excision of the cutaneous cap, the replacement of cord and zona medulovascularosa in the spinal canal, closure of the dura, which encircle the neck of the sac, utilizing all of the dura present to form a wide covering for the cord and membranes, at the site of the defect. The muscles were closed by the Frazier method.

Progress.—Child made an uneventful recovery. Discharged from the hospital, October 1, 1925. We have not been able to trace this case since her discharge. Figure 13 shows closure after operation.

CASE XIII.—E. J., male, two months of age. History No. M-3253, admitted October 25, 1923. X-ray examination showed a defect of 2-3-4-5 lumbar vertebrae, a large meningomyelocoele was present. Operation October 28, 1923.—Patient died eight hours after operation; cause of death, operative shock.

CASE XIV.—M. N., female, age two months. History No. M-3531, admitted October 17, 1923. Diagnosis, meningomyelocoele, lumbar region. Operation October 20, 1923. Under ether anaesthesia, excision of cutaneous cap, replacement of zona medulovascularosa, arachnoid and nerve structures in spinal canal. Closure of the dura.

Progress.—Patient reacted from the anaesthetic. No evidence of operative shock. Third day developed temperature 100, pulse 120. From third to eighteenth day the child showed progressive signs of meningitis. She died on the eighteenth day from septic meningitis.

CASE XV.—L. S., male, age six months. History No. P-607. Admitted to the hospital, June 15, 1926. Diagnosis, meningomyelocoele of the lumbo-sacral region. Operated on June 29, 1926, and died the same day; cause of death, operative shock.



# HEART INJURIES—WITH SUTURE\*

By HERBERT H. SCHOENFELD, M.D.  
OF WASHINGTON, D.C.

GEORGE FISCHER, in 1868, compiled a series of 452 cases of heart injuries, with a 10 per cent. recovery without surgical intervention. Sometime later Block, in 1882, recorded his observations on experimental wounds of the heart in rabbits, which were treated surgically. Billroth, in spite of this, stated in unequivocal terms that "the surgeon who should attempt to suture a wound of the heart would lose the respect of his colleagues." At the eleventh International Medical Conference in Rome, Del Vecchio demonstrated healed wounds of the heart in dogs following suture; and about one year later, in September, 1895, Cappelan of Norway operated the first described case in the human subject. The second was done by Farina of Rome in March, 1896. The third was done by Rehn of Frankfurt in September, 1896. That of Rehn was the only one of the three to recover. In 1908, Vaughn reported a series of 150 cases compiled from the literature, including a second case of his own, which resulted in a successful termination.

I have taken, for the purpose of presentation, the compilation of Peck, in the ANNALS OF SURGERY, 1909. Of the cases operated from 1896 until that date, there are 160 cases listed.

Total recoveries	59.....	36.87 per cent.
Total deaths	101.....	63.13 per cent.
In O.R.	16.....	10.00 per cent.
In 24 hours	28.....	17.50 per cent.
Within 7 days	38.....	23.75 per cent.
After 7 days	19.....	11.87 per cent.

The next compilation I have taken is that of Pool, listing 77 cases between 1909 and 1912, published in the ANNALS OF SURGERY in 1912.

Total recoveries	42.....	54.5 per cent.
Total deaths	35.....	45.5 per cent.
In O.R.	8.....	10.4 per cent.
In 24 hours	11.....	14.3 per cent.
Within 7 days	11.....	14.3 per cent.
After 7 days	5.....	6.5 per cent.

The third compilation, listing 49 cases from 1912 to 1923, is by Smith, published in the ANNALS OF SURGERY in 1923.

Total recoveries	35.....	71.44 per cent.
Total deaths	14.....	28.56 per cent.
In O.R.	3.....	6.12 per cent.
In 24 hours	6.....	12.24 per cent.
Within 7 days	4.....	8.16 per cent.
After 7 days	1.....	2.04 per cent.

\* Read before the George Washington University Medical Society, Dec. 17, 1927.

## HERBERT H. SCHOENFELD

Age of patient Name of surgeon Date	Etiology Location	Time between injury and operation	Drainage	Complications	Sequelae	Result
Rhodes: 1922: 16 years	Stab wound r. ventricle	About 2 hrs.	No	None	None	Died on table.
Vautrin & Guillemain: 1922	Stab wound l. auricle	1 ½ hrs.	No	None	None	Recovery.
Klose: 1922: 40 years	Stab wound r. auricle	3 hrs.	Yes	D.T.: Pericarditis; Broncho-pneumonia	None	Died, 18 days.
Rhodes: 1923: 23 years	Stab wound r. auricle	About 1 hr.	No	Pericarditis: Pleurisy; Ac. Tonsillitis. Etc.	Few pleural adhesions	Recovery.
Drummond: 1924: 25 years	Stab wound l. auricle	2 hrs.	No	Pneumothorax: pleural effusion	None	Recovery.
Maguire: 1924: 18 years	Stab wound r. auricle	About 2 hrs.	Yes	Pleural effusion	None	Recovery.
Meyer & Brams: 1924: 37 years	Gunshot wound l. ventricle	About 6 hrs.	No	None	Slight sinus arrhythmia	Recovery.
Brocq: 1924: 35 years	Stab wound l. ventricle	About 1 hr.	No	Heart stopped on table; started with massage	None	Recovery.
Comolli: 1924: 38 years	Stab wound l. ventricle	4 hrs.	Yes	None	None	Died, 5 hours.
Grove, Fernandez & Grove: (6 cases): 1924 #1. 23 years	l. ventricle	Immediate operation	No	None	None	Died, 4 hours.
#2. 30 years	Stab wound l. ventricle	Not stated	No	None	None	Died, 15 days.

Under cystic lymphangioma are collected those tumors with a great number of thin-walled convoluted cysts which are filled with lymph or lymph-like fluid, and which are bound together by connective tissue. This stroma contains many smaller spaces which may eventually go on to large cavity formation.

Workers like Nasse,<sup>11</sup> Ribbert,<sup>12</sup> Sick<sup>13</sup> and Henschel<sup>14</sup> have interpreted the origin of cystic omental tumors from embryonally misplaced nests, potentially capable of producing lymph channels, or from post-natally developed connective tissue also

having such potentialities. Others have contended that cystic lesions of the omentum, like cystic lesions in other portions of the abdominal cavity, were not tumors, believing that they arose as a result of stasis of the efferent lymph channels, and that the proliferative changes were due to the irritative effects of the early results of pressure. In support of this contention Wegner's original experiments are usually quoted in which he filled

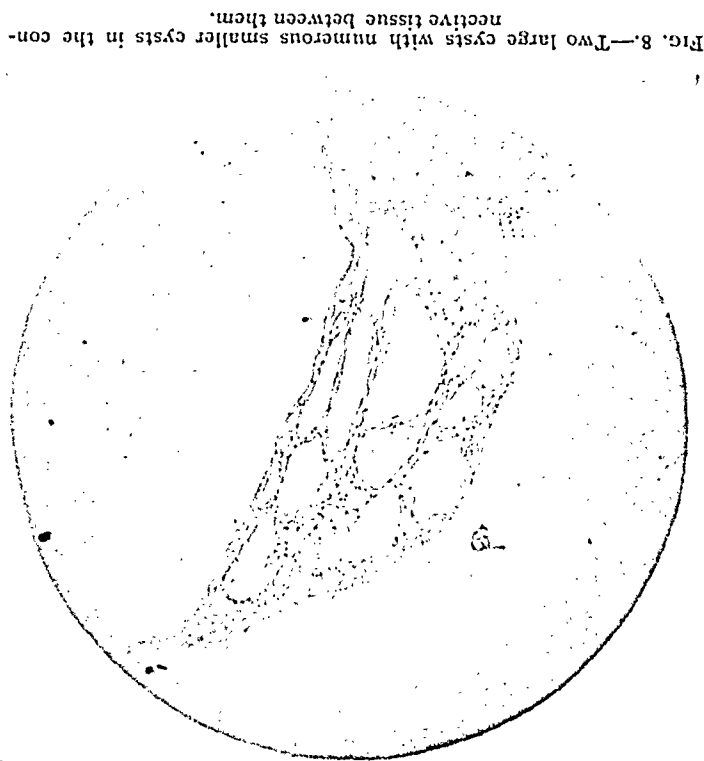


FIG. 8.—Two large cysts with numerous smaller cysts in the connective tissue between them.

the abdominal cavity with air and continued the increased abdominal pressure for some time. The air entered the subperitoneal lymphatics and the lymphatics of the greater omentum, leading to obstruction of the draining vessels with the consequent production of large cysts with proliferative changes in the walls.

On the other hand, Langhans and Ribbert have denied the participation of stasis in the development of these tumors, though others like Borst,<sup>15</sup> Sick and Borchers believe that stasis plays an important but secondary rôle, and leads only to the enlargement of the tumor.

On the basis of our case we believe that the tumor is a true blastoma; that it arises from a mesenchymal connective tissue capable of producing lymphatic channels; that the preëxisting lymph channels of the greater omentum are not involved in the true tumorous proliferation; that if these channels are involved and become cystic, it is due to the obstruction of their lymph flow and that if proliferative changes do occur in their walls, they are due to this obstruction. Many of the new-formed tumorous lymph chan-

# HEART INJURIES—WITH SUTURE

#3. 20 years	Stab wound l. auricle	?	Yes	None	None	Recovery.
#4. 18 years	Stab wound l. ventricle	?	No	None	None	Recovery.
#5. 20 years	Stab wound l. ventricle	?	No	Purulent pericarditis	None	Died, 25 days.
#6. 27 years	Stab wound l. ventricle	?	No	None	None	Recovery.
Long (2 cases): 1925: #1. 32 years	Knife: left auricle	?	Yes	Serous effusion	None	Recovery.
#2. 45 years	Stab wound l. ventricle	?	No	None	None	Recovery.
Schoenfeld: 1925: 12 5 years	Stab wound l. ventricle	About 3 hrs.	No	None	None	Recovery.
Brocq: 1925: 24 years	Gunshot wound l. ventricle	About 3 hrs.	No	None	None	Died, 48 hours.
Flach: 1925:	Knife: l. ventricle	1 hr. or less	Yes	Pneumonia	None	Died, 5 days.
Otto: 1925: 24 years	Stab wound r. ventricle	?	No	Osteomyelitis	None	Recovery.
Lenormant: 1926	Stab: r. ventricle	About 2 hrs.	No	Pericarditis	None	Recovery.
Duschl: 1926	Stab: r. ventricle	?	No	None	Incapacitated	Recovery.
Davenport: 1920: 44 years	Stab wound r. ventricle	About 1 ½ hrs.	Yes	None	None	Recovery.
Hesse: 1921: 40 years	Gunshot wound l. ventricle	2 hrs.	No	None	None	Died, 2 days.

We have examined the literature, and the individual cases reported in the literature from 1923 to 1926, finding 25 cases, including our own. (See Table.)

Total recoveries	16	64.0 per cent.
Total deaths	9	36.0 per cent.
In O.R.	1	4.0 per cent.
In 24 hours	2	8.0 per cent.
Within 7 days	3	12.0 per cent.
After 7 days	3	12.0 per cent.

The majority of injuries of the heart reported in the literature are stab wounds, usually with sharp instruments, and, less frequently, are due to gunshot wounds.

Death most frequently occurs very promptly, due to shock and hemorrhage, before any treatment can be instituted. The classical symptoms described many years ago include an anxious expression with restlessness; the patient may be unconscious; there is marked shock with pallor and cyanosis; the skin is covered with cold sweat; there is usually dyspnea, the pulse being feeble and fast.

The physical examination shows a wound over the precordium which frequently does not bleed extensively. There may be evidence of pneumothorax or haemo-pneumothorax. The precordial area of dullness may or may not be increased in size. The apex impulse is altered. The heart sounds are usually distant.

The diagnosis of cardiac injuries is not always easy, the diagnosis being made upon symptoms which may sometimes be very readily confused with, and present an almost identical picture to that of pulmonary, pleural, and pericardial injuries.

The surgical treatment should be prompt, even in the face of many usually definite contra-indications to surgical intervention. It is felt that the gravity of heart injuries demands exploration, because, as may be seen by the figures presented above, prompt intervention has reduced the mortality of heart injuries from about 63 per cent. reported in the first series in 1909, to approximately 30 per cent. at this time.

Time does not offer for the presentation of the types of operation which may be performed, but the statement should be made that surgery should be carried out early, and that generally speaking, better results have been obtained by complete closure without drainage. Drainage lends more possibility of infection, and infection is the principal factor, along with bronchopneumonia, in the late mortality of these patients.

The repair of heart injuries is generally conceded to be carried on in the same fashion as the healing of other tissues; namely, by the laying down of fibrous tissue. Heart muscle does not regenerate in these cases. Around the area of scar there is, however, described an area of hypertrophy of the muscle cells.

## HEART INJURIES—WITH SUTURE

CASE REPORT.—Melvin Jones, aged five years, was admitted to the Children's Hospital about 2 P.M. on September 20, 1925, with a history of having run into or fallen upon a pair of scissors at about 12.30 P.M.

At the time of admission, he was in profound shock, had a marked pallor, some cyanosis, the extremities being cold and clammy, and the body bathed in cold sweat. The pulse was hardly perceptible, and there was a puncture wound in the fourth left costal interspace, about one inch from the edge of the sternum. The left chest was hyper-resonant, particularly over the cardiac area, to beyond the left nipple line. The heart sounds could not be heard, and there was bronchial breathing over the cardiac area.

The child was given normal salt solution by hypodermoclysis, immediately, and about sixteen minims of fibrogen, following which the pulse picked up slightly.

An X-ray made at this time showed the heart normal in size and position; the lung field entirely clear. There was no evidence of pneumothorax. The lung was in no way retracted, and there was no evidence of fluid.

At about 3.40 P.M., under ethylene-oxygen anæsthesia, an incision was made through the superficial tissues over the third rib, from the costo-chondral junction to the chondro-sternal junction. A similar incision was made above the fifth rib, and the flap of skin and muscle was turned laterally. The third and fourth ribs were cut through at the costo-chondral and chondro-sternal junctions, the third and fifth intercostal muscles being sectioned transversely and at the sternum, and the entire flap was turned laterally. Following the control of hemorrhage from the internal mammary artery, the pericardium was opened transversely, releasing a large blood clot, and some free blood, from the pericardium. (It is interesting to note that on opening the chest the pericardium had dropped away from the thoracic wall.) The heart, as well as the pericardium and superficial tissues, showed a small puncture, one-quarter inch in length, extending longitudinally on the anterior surface of the left ventricle about one and one-half inches above the apex, from which, on contraction, a stream of blood was ejected about sixteen to eighteen inches. This wound was closed with two interrupted silk sutures, following which the pericardium was closed, and the superficial tissues were sutured without drainage. During the closure, high pressure was exerted by the anæsthetist with his closed anæsthesia for the purpose of dilating the collapsed lung caused by pleural injury. A large flat dressing was applied over the wound, and an adhesive dressing applied to the left chest. At the conclusion of the operation, the pulse was quite perceptible and of good force. A transfusion of whole blood was not easily done, but about a hundred c.c. of blood, which could not be infused, was given per rectum.

The day following the operation, the patient was greatly improved in every way. He was seen in consultation with Doctor Wall before leaving the hospital, who reported the chest examination normal except for slight bulging in the lower left chest anteriorly; a diffuse, poorly defined apex beat, one and one-quarter inches below the nipple; and a slight decrease in the intensity of the respiratory sounds in the left chest. The convalescence was steadily progressive up to the time of his discharge from the hospital, October 29, 1925.

On December 7, 1927, Dr. Thomas S. Lee, of Washington, very kindly consented to give the child a thorough cardio-vascular examination, which showed the chest symmetrical, except for the operative scar. Expansion was good and even on both sides; no visible pulsation; moderate epigastric pulsation when recumbent. The apex beat was barely palpable in the fifth intercostal space, within the midclavicular line. The size of the heart was normal, the teleröntgenogram showing the transverse diameter of the heart to be 8 cm., and that of the chest 19½ cm. The aortic arch was not enlarged. There were no murmurs or other signs of pericarditis or endocarditis. The myocardium was in satisfactory condition, as was shown by the quality of the cardiac tones, the normal response to moderate exercise tests, and the normal electro-cardiogram. The heart rate, sitting, was 100, the patient being somewhat nervous under examination. There was a moderate degree of sinus arrhythmia, which is of no clinical significance

in a child. The blood pressure was systolic 100 mm., diastolic 60 mm., in both arms. There was no sign of circulatory inefficiency in the lungs, the liver, or elsewhere.

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# PRIMARY HYPERNEPHROMA OF THE LIVER\*

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THE observation of hypernephroma as a secondary or metastatic deposit in the liver is a common one, its definite identification as a primary growth therein is a rare one.

The existence of accessory suprarenal capsules or adrenal cell nests disseminated at more or less distant points from the chief gland was more or less discredited until Morgagni (1740) confirmed it by his personal observations. The first instances of accessory adrenal tissue were reported by Piccolomini (Peperé) in 1856, since which time various authors have reported them in sundry portions of the urogenital tract and in the abdominal viscera. Bothe gives the following organs and tissues tabulated by Broman, in which adrenal cell nests have been found:

1. *In the male:*
  - In the rete testis and epididymis.
  - In the paradidymis.
  - On the spermatic cord, in the inguinal canal, and above and below the same.
2. *In the female:*
  - In the ovary, where they may be mistaken for shrunken corpora lutea.
  - On the tubes.
3. *In both sexes:*
  - In the retroperitoneal tissue below the poles of the kidneys.
  - Along the internal spermatic and ovarian veins.
  - On the iliopsoas muscle at the brim of the pelvis.
  - At the sacro-iliac synchondrosis.
  - In the capsule of the kidney and in the kidney substance.
  - On the wall of the neighboring vessels.
  - In the solar and sympathetic plexuses.
  - Between the transverse colon and the spleen.
  - In the right lobe of the liver.
  - In the pancreas.

Schmorl, in 1891, reported finding adrenal cell nests in the liver four times in 510 autopsies. Beer in 1904, reported the examination of 150 livers for suprarenal inclusions, in six of which adrenal cell nests were found without any evidence of tumor formation. In five of the cases the inclusions lay partly in and partly just beneath the liver capsule. In one case the inclusion lay in the parenchyma and was separated from Glisson's capsule by an acinus. The suprarenal inclusion was not adherent to the liver in any of the cases and there was no inflammation. In all of the cases the inclusions were adults and in all lobe near the suprarenal impression. All the subjects were adults and in all the microscopic picture was typical of suprarenal tissue. The high proportion

\* Read before Southern Surgical Association meeting, December 14, 1927, Augusta, Georgia.



of inclusions found by Beer will not hold good in general, but it shows the importance of making an examination for suprarenal tissue in any primary tumor of the liver, particularly when not originating in the liver cell. The embryological explanation of such inclusions is made clear by the work of a number of authors, the report of one of which, Bothe, is in part as follows: "The original studies were made with the hope of obtaining cross-

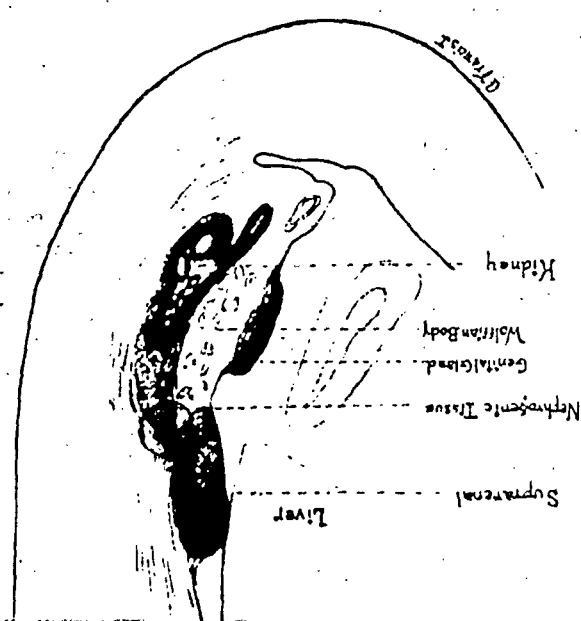


FIG. 1.—See text.

sections of embryos at an age when the anlage of the cortical substance of the suprarenal gland and metanephros are to be found at the same level. Of the specimens studied, including pig embryos of 7, 12 and 19 mm., and human embryos of 7, 12 and 16 mm., respectively, the 16 mm. human embryo alone revealed the two anlages in close proximity. In this specimen cross-sections made at the upper pole of the metanephros disclosed the presence of the component cells of this structure together with the cortical substance of the suprarenal gland in the closest proximity and at a fairly early developmental stage. The illustration (Fig. 1), which is a modification of the one presented by Wilson and Willis, shows the approximate level at which these sections were cut, namely at the level of the upper pole of the mesonephros. The illustration (Fig. 2) shows the relation of the respective anlagen in cross-section at this level. In describing the section and taking the aorta as a fixed point we find ventrolaterally to it a collection of cells in the mesenchyme representing the cortical substance of the suprarenal gland. The identification of the latter structure is dependent upon the characteristic cortical cells, with a somewhat irregular outline and a large nucleus. Scattered between these cells, are imperfectly formed blood sinuses which are identified by the presence of endothelial cells. The arrangement of the above described cells into strands is the typical finding in the adrenal anlagen. Ventrolateral to these suprarenal cells is the mesonephros and genital ridge, with the mesonephros placed in a lateral position. In this section, as is shown by the illustration, it is difficult to determine the limits of the cortical cells: there is no definite limiting tissue. When studied under high magnification a very narrow band made up of young connective-tissue cells is deflected separating these two anlagen, but the separation is in places very poorly defined, being effected by only one or two connective-tissue cells. The anlagen cells of the adrenal are so situated with respect to the liver, kidney, ovary, testicle, epididymis and

## PRIMARY HYPERNEPHROMA OF THE LIVER

uterus that one can easily see the possibility of adrenal cell inclusions in these organs."

Accepting the theory of Grawitz that hypernephromata are developed from adrenal cell nests the explanation for their occurrence in the liver is at hand. All of the suprarenal inclusions reported by Beer were in the right lobe near the suprarenal impression. In the cases of primary hypernephroma in the liver found in the literature reported in sufficient detail to determine localization seven (de Vecchi, Donati, de Ahna, Hirschler, Cirio, Williams, Swenson) were in the right lobe, one (Peperé) in the left lobe, and two (Starr, Harrigan) in the folds of the falciform ligament, all being in adults. Of the ten cases the tumor was discovered at autopsy in three, two were explored surgically and later recovered at autopsy, while five were surgically removed with recovery of patients.

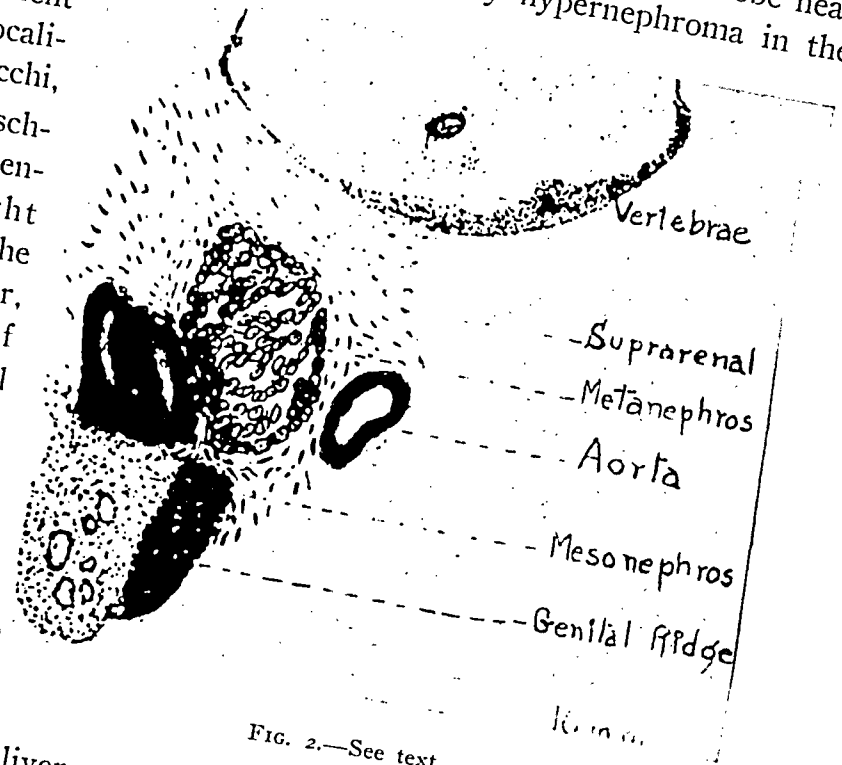


FIG. 2.—See text.

Of the eight occurring in the liver practically all are described as more or less encapsulated tumors situated at the lower border of the liver, some immediately under Glisson's capsule, others completely covered with liver tissue. De Ahna states that fetal inclusions of suprarenal tissue in the liver are generally found on the lower surface of the right lobe: generally they are just beneath Glisson's capsule, but they may be pushed deeper into the parenchyma by the growth of the liver cells and become surrounded on all sides by liver tissue. Here they may remain quiescent, atrophy from pressure or give rise to tumor formation. It is suggested by Hirschler that the reason they are so rarely found in the liver, in comparison with other locations, is that the liver tissue crushes them out entirely as they do not have a very active capacity for growth. The microscopical picture does not differ from hypernephroma originating elsewhere and in the primary deposits there is no involvement of liver cells other than atrophy from compression.

The writer desires to add to the above mentioned cases a report of one of like character coming under his observation.

CASE REPORT.—A. G., female, white, age thirteen months, an only child, came under observation June 16, 1926. Its mother had noted an enlargement in the abdomen one month before and stated that the latter had increased rapidly in size. No change in the child's health had been observed; it was playful, had a good appetite and slept well.

No evidence of discomfort on urination and the character of urine as observed on the napkins had shown nothing unusual. Examination showed a well-developed, well-nourished baby weighing nineteen pounds, with negative findings other than a large rounded mass filling the right half of the abdomen and extending to the left of the midline. While movable, it filled the abdominal cavity to such an extent that no definite conclusion as to its attachment could be reached. X-ray films revealed nothing further than a large rounded tumor. A tentative diagnosis of a right renal embryoma was made and explor-

ation advised. Abdomen opened June 22, 1926, by incision in right linea semilunaris extending from costal margin to a point above Poupart's ligament. Tumor found to originate in the liver being oblong and rounded, approximately five inches in its longest diameter and three inches in its shortest. It was seemingly distinctly encapsulated and connected with the right lobe of the liver by a compressible amount of liver tissue, its attachment corresponding to the entire anterior border of the right lobe extending from the tip of the



FIG. 3.—Free surface—130 x 90 x 60 mm. Weight 460 gms.

twelfth rib to a point slightly to left of the umbilicus. The liver tissue was compressed between two rubber covered stomach clamps and the tumor cut away. A haemostatic running suture of mattress type was then passed through liver tissue distal to clamps. The cut liver edges were brought together by a running suture of catgut. The remaining portion of liver was negative to palpation and inspection: the glands along its lower border showed definite enlargement. Kidneys, adrenals, spleen and remainder of abdominal organs were negative. The patient made an uneventful recovery and at the last examination, November 10, 1927, seventeen months after operation, she presented no evidence of recurrence. She was at that time thirty months of age, weighed thirty pounds, and was well nourished. The abdomen showed the right rectus scar in good condition; no rigidity; no masses.

The tumor was examined by Professor Graves of the Department of Pathology, Medical School of the University of Louisville, whose report is as follows:

PATHOLOGICAL REPORT.—*Gross Description*.—Specimen consists of fairly firm, encapsulated, oval, reddish-gray mass, 130 x 90 x 60 mm., weighing 460 gms. and faintly lobulated. Cut surface is brownish-gray, lobulated and moist. Inner tissue is very friable. *Microscopical Description*.—Sections from different portions of tumor show a delicate neoplasm, mostly sharply circumscribed with fibrous tissue, but in places tongues of tumor tissue seem to be infiltrating between lobules of surrounding liver tissue. In the neoplasm itself are fairly numerous large, thin-walled blood-vessels with tumor cells directly adjacent. The tumor cells tend to be arranged in lobules of uneven size and shape, separated by thin, interlacing bundles of fibrous tissue. Otherwise there is very little stroma and individual tumor cells lie in close contact. These cells are rounded or polyhedral with delicate, distinct outlines. The nuclei are small, rounded and tend to lie central. The cytoplasm is scanty, pink and finely granular. The delicate, lace-like appearance

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under low power magnification, as well as the detailed appearance of the cells under high power, seems identical with that of hypernephroma. Study of the individual cells reveals no pigment. Mitoses seem absent. There are no structures resembling bile ducts.

*Microscopical Diagnosis.*—Hypernephroma. Figures 3, 4, 5, 6, 7.

### SYNOPSIS OF HISTORIES OF REPORTED CASES

1. A. Peperé. 1902. Female patient admitted to hospital in grave condition, pleurisy, evening fever, rapidly increasing ascites, which on paracentesis showed a hemorrhagic character. Liver showed enlargement with irregularity of its surface. Clinical diagnosis—malignant neoplasm of liver, probably sarcoma. Autopsy: The surface of the liver was rendered unequal by many yellowish-white nodules of neoplastic appearance, the left lobe being entirely transformed into a neoplastic mass. Spleen, kidneys, adrenals, pancreas, uterus, ovaries, peritoneum, retroperitoneal and mesenteric glands negative for evidence of tumor. The lungs were studded with yellowish-gray nodules the size of a pea. No further metastases found. Histologic examination showed the tumor to be hypernephroma. Peperé calls attention to this case as the first one of primary hepatic tumor arising from aberrant rests of the suprarenal capsule to be described.



FIG. 4.—Attached surface—130 x 90 x 60 mm. Weight 460 gms.

2. B. de Vecchi. 1904. Female, age twenty-nine, died of puerperal sepsis. A routine autopsy was done, during the course of which a "walnut-sized" tumor was found in the right lobe of the liver above the suprarenal impression. The tumor was entirely surrounded by liver tissue. There was no definite capsule as the boundary was formed by a fusion of the coverings of different lobules of the liver, the adjacent liver cells being atrophied and compressed. There were no further lobules in the liver or elsewhere. Microscopical examination showed hypernephroma. The literature of the subject is reviewed and the view expressed that suprarenal inclusions are probably carried to the liver by the circulation.

3. M. Donati. 1905. Female, age thirty-six, with history of movable tumor in right half of abdomen for six months. The tumor had recently become sensitive and painful, and at time of admission to hospital patient had high fever and presented a sensitive mass movable with liver on respiration. Operation, with tentative diagnosis of suppurative cholecystitis, revealed a tumor of the right lobe of the liver which was removed after placing an elastic ligature around its base. It weighed 370 grams and was covered with a layer of liver tissue 1.2 to 1 cm. thick. The patient recovered. Microscopical examination revealed hypernephroma. The author is inclined to agree with Peperé's theory that the inclusions are carried to the liver by the circulation.

4. M. Hirschler. 1912. The author gives abstracts of cases of hypernephroma of the liver by Schmorl, Kaufman, Peperé and de Vecchi, all autopsy findings, and which he says are the only cases in human beings described in the literature. His own case was in a man of fifty-two dying of diabetes and tuberculosis. The liver tumor had caused no symptoms during life and had not been diagnosed. It occupied almost half of the right lobe of the liver and was almost the size of a "child's head," being 11 cm. in

diameter. The surface of the tumor nearest Glisson's capsule was covered with 1 cm. of liver tissue. The capsule around the tumor was intact except in a few places at which actively proliferating tumor tissue had broken through it. The metastatic nodules in the surrounding liver parenchyma were just like the chief tumor. The liver tissue around the tumor was compressed, the cells small, irregularly shaped, atrophic and many of them filled with yellowish-brown pigment. Microscopical diagnosis: hypernephroma. He cites other cases in which suprarenal inclusions have been found buried in liver parenchyma and is inclined to disagree with Peperé's theory that such inclusions are carried by circulation and to agree with Schmorl's theory that liver tissue gradually grows around deposits of suprarenal tissue on its lower surface and may push them deep into the parenchyma.

5. De Ahna, 1912. Male, age forty-five, with a history of pain in the right side of abdomen for eight weeks. There was a large tumor in the right flank which moved downward with respiration and appeared beneath the costal arch. On palpation it could be pushed upward under the ribs. The left kidney region was free: the right kidney urine showed pus, the left none. Operation by Professor Hildebrand, tentative diagnosis, renal hypernephroma, revealed the tumor to originate in the right lobe of the liver. It was enucleated and its bed closed with suture. Patient recovered. The tumor was the size of a "child's head" and everywhere except where it had been attached to the liver was covered by a thickened Glisson's capsule. Microscopical diagnosis: hypernephroma. The author discusses suprarenal inclusions, refers to Hirschler's report (*vide supra*) published the same year and mentions that he was unable to find any case in literature analogous to this one, since it was the first operation reported for hypernephroma of the liver.

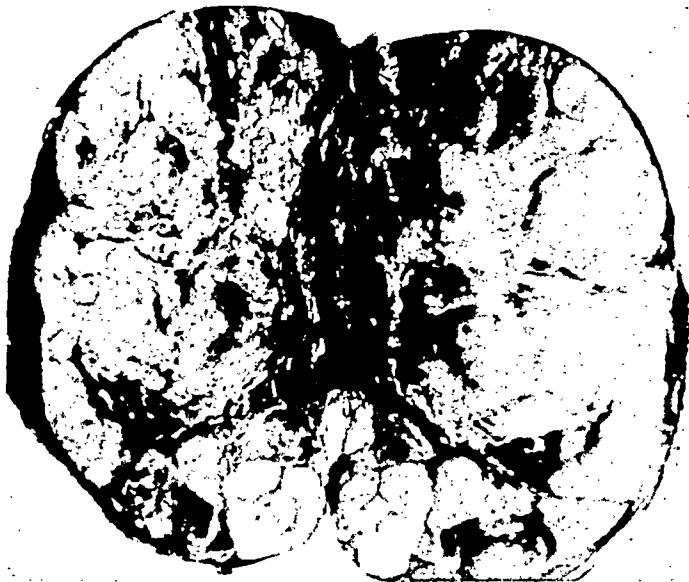


FIG. 5.—Cut surface, brownish-gray, lobulated, moist.

6. F. N. G. Starr, 1917. Female, age thirty-five, presented a mass most prominent in the epigastric region, extending from the costal margin above to about four inches below the level of the umbilicus. Pre-operative diagnosis lay between—(a) an atypical pancreatic cyst, (b) an hydatid of the liver, and (c) a collection of fluid in the lesser cavity. At operation a tumor weighing eight and one-half pounds was found between the layers of the falciform ligament of the liver and removed without rupture. Patient recovered. Microscopical diagnosis: hypernephroma.

7. Carl G. Swenson, 1917. Female, age fifty-eight, ill one year with history of "lump" in epigastrium for seven months. At operation tumor found to arise in the right lobe of the liver, requiring an excision of 2 by 10 cm. of the latter for complete enucleation. Patient recovered from the operation with recurrence of the growth eleven months later. The diameter of the tumor measured 12.5 cm. and it weighed 2 kilograms. Microscopical diagnosis: hypernephroma.

8. A. H. Harrigan, 1917. Female, age thirty-five, with history of severe pain in right upper quadrant of abdomen during two years. Diagnosis: chronic appendicitis and possibly cholecystitis. Operation: appendix removed—gall-bladder and biliary ducts negative for stone. A "walnut-sized" tumor was removed from the falciform ligament

nels become obstructed and dilated, though it is conceivable that many, because of their tumorous nature, are blind and become cystic on this account. It is our opinion that while stasis does occur in these growths, it is secondary to the real tumorous nature.

The fluid of these cysts varies in color from water clear to dark brown, and may be of a thin watery to a thick pasty consistency. It is alkaline in reaction, and coagulates on boiling because of its high globulin and albumin content. The sediment shows fatty endothelial cells and cholesterol crystals, though Gödel<sup>10</sup> described the presence of many lymphocytes. No mucin is present in the fluid. The chylous cysts contain a milky fluid which Henschen showed had much in common with chyle on chemical analysis. Undoubtedly lymph seems to be of primary importance in the formation of the fluid content of these cysts, and variations of the cyst fluid from normal lymph are due to factors such as filtration, diffusion, secretory activity of the cyst wall endothelium and degeneration.

This report deals with endothelial lined cysts and excludes all epithelial lined cysts of the greater omentum which may result from embryonic inclusions.

#### CONCLUSIONS

Another case of cystic lymph tumor of the greater omentum is added to the small number of cases already recorded in the literature. We believe that cystic lymphangiomas are true blastomas arising in the greater omentum from undifferentiated mesenchyme which is capable of producing lymphatic vessels by proliferation of lymphangioblasts. Many of these newly formed lymphatic vessels become enlarged and cystic, due to the blocking of the outlets and possibly because they are blind vessels. Some of the original lymphatic vessels are also obstructed and show secondary changes such as dilatation and proliferation of the endothelium. We believe that the preformed lymphatics are not involved in the tumor growth.

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## PRIMARY HYPERNEPHROMA OF THE LIVER

close to the free border of the liver. Closure with suture. Patient recovered. Microscopical diagnosis: hypernephroma. Embryological explanation is discussed as is also the theories of Wilson, Growitz and Stoerch regarding hypernephroma.

9. L. Cirio. 1922. Autopsy report of twenty-eight-year-old man dying after exploratory laparotomy for abdominal tumor. Nodular tumor of the size of the "head of a fetus" attached to the free border of the liver to the left of the gall-bladder which had developed outside the liver toward the transverse mesocolon and the hepatoduodenal ligament. Many nodes scattered irregularly in the liver which showed the same appearance as the chief tumor. There were no new growths in any of the other organs; the suprarenal bodies were flattened and intensely pigmented. The nodes were as a rule encapsulated, the liver tissue around the tumor was compressed but with no signs of new growth of the liver tissue itself. Where the capsule was lacking there was no boundary between the liver tissue and tumor tissue, the cells of which showed an active tendency to proliferation. Microscopical diagnosis: primary tumor of the liver derived from inclusions of suprarenal cortex.

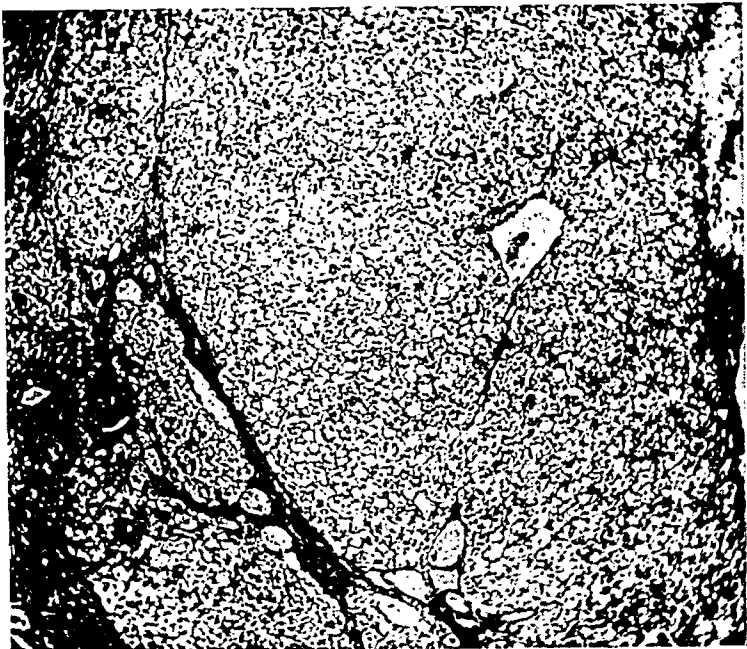


FIG. 6.—Low power microphotograph.

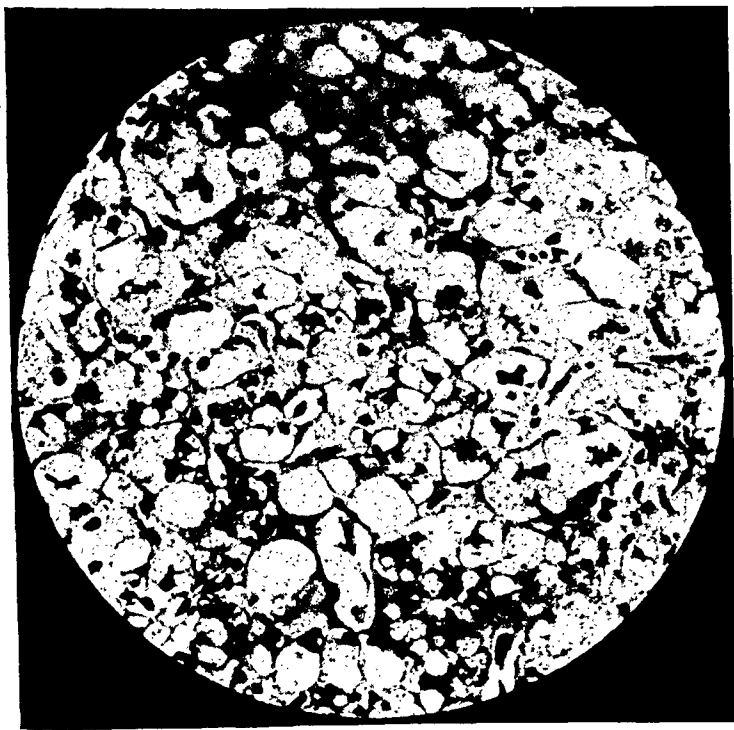


FIG. 7.—High power microphotograph.

10. L. Williams. 1923. Female, age sixty-eight, with a history of acute pain in abdomen two years previous to admission to hospital, at which time a mass was discovered in the right side of the abdomen, apparently in the region of the kidney. At time of admission neuritis of right side of chest and right shoulder, difficulty in breathing and a sense of fulness in epigastrium were noted. The liver was palpably enlarged and the mass below and behind the liver appeared to be about the same size as on previous examination. Exploratory operation by Dr. Carl B. Davis. Liver found to be studded with tumor nodules, one of which was removed. Microscopical examination disclosed a hypernephroma. The patient lived seven months and

autopsy revealed a primary hypernephroma of the liver with extension and metastases in the remainder of the organ. The tumor tissue was found limited entirely to the liver, no metastases being found outside this viscus.

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## REMOTE RESULTS OF BILIARY SURGERY\*

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OUR knowledge of disease processes has been broadened by a study of so-called "Inaugural symptoms" (the monument left to us by the late Sir James Mackenzie), likewise by experiences met with in the recently popularized Periodic Examination of the Apparently Healthy, but definite concrete information relative to the value of certain lines of treatment, or management, call for: 1. Information as to the natural history of untreated disease. 2. Knowledge as to the immediate result of treatment: (a) Relief of symptoms, (b) mortality. 3. Knowledge as to the remote result of treatment. (a) Permanent cure, (b) return of symptoms.

1. The natural history of untreated disease has been given very little serious consideration: but with social services extending from our hospitals to industries, life insurance companies, schools and communities, accurate information will be forthcoming.

2. The immediate result strikes one in the face, is dramatic, has been given much attention; with the mortality rate assuming the most important aspect and relief of symptoms being often mistaken for cure.

3. Remote results, in contrast, are prosaic, many times are not enquired into and frequently too much, usually on the favorable side, is taken for granted; they have been given comparatively little serious study; but, of late, are causing interest which is a natural corollary to the enthusiasm with which the beginnings of disease are being searched for.

In my personal records from 1910 to 1920 I find 336 cases of biliary tract disease of which 150 were not operated upon and 186 were treated surgically. Of those surgically treated, 33 are dead; in 54 the result is unknown, leaving 99 cases in which we are familiar with the post-operative history.

Of the 33 deaths, 4 deaths were remote and unrelated, 2.1 per cent.; 12 deaths were secondary (three months or more after operation), 6.4 per cent.; 17 deaths were primary, 9.1 per cent.; total, 33 deaths, 17.6 per cent.

Of the 17 primary deaths, two followed simple exploratory incisions for malignant disease of the liver; subtracting these two cases leaves 184 cases with 15 primary deaths, that is 8 per cent.

The causes of the 15 primary deaths were recorded as peritonitis, 3; sepsis, 1; sepsis and jaundice, 2; acute hemorrhagic pancreatitis, 1; kidney stone, 1; nephritis, 1; pneumonia, 2; myocarditis, 4; usually not due to method of operating or presence or absence of calculi and will not be considered under this title.

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\* Read before the Western Surgical Association, December 9, 1927.

The 12 secondary deaths were: Cancer of stomach, 3; colon, 2; kidney hypernephroma, 1; myocarditis, 3.

The 4 remote, or unrelated, deaths were: myocarditis, 1; pulmonary tuberculosis, 1; cerebral hemorrhage, 1; railroad accident, 1.

It is of interest to note that of the 33 deaths, carcinoma was a factor in 15 instances (stomach 5, liver 5, colon 2, pancreas 2, kidney 1).

It is to the question of *remote* results, permanent cure or return of symptoms, rather than immediate results, relief of symptoms or death, that I would like to direct attention; no case in this discussion was operated on later than 1920, allowing a fair estimate as to really remote results.

Of these 99 cases with known result, 40 (40.4 per cent.) had a return of symptoms but subsequent developments showed in 15 cases the symptoms subsided spontaneously, and in seven relief followed secondary operations. Deducting these 22 leaves in the last analysis 18 of the 99 cases with a return of symptoms, 18.1 per cent.

Classified according to the presence or absence of calculi one finds:

Calculous 69, with 33 return of symptoms (47.8 per cent.).

Cholecystostomies 45, with 25 return of symptoms (55.5 per cent.).

Cholecystectomies 24, with 8 return of symptoms (33 $\frac{1}{3}$  per cent.).

Non-calculous 30, with 7 return of symptoms (23.3 per cent.).

Cholecystostomies 22, with 5 return of symptoms (22.7 per cent.).

Cholecystectomies 8, with 2 return of symptoms (25 per cent.).

In the calculous cases the return of symptoms was 47.8 per cent., twice as high as in the non-calculous cases, 23.3 per cent.; this can probably be explained by the fact that the non-calculous case is frequently less complicated or perhaps an earlier phase of calculous disease, therefore more amenable to permanent cure after suitable treatment. Of course the probability of mistaken diagnosis is much greater in the non-calculous than in the calculous type of the disease, if such errors could be excluded it would tend toward making the return of non-calculous cases smaller and emphasize the difference still more strongly.

Considered from the point of view of the type of operation one finds:

Cholecystostomies 67, with 30 return of symptoms (44.7 per cent.).

Calculous cholecystostomies 45, with 25 return of symptoms (55.5 per cent.).

Non-calculous cholecystostomies 22, with 5 return of symptoms (22.7 per cent.).

Cholecystectomies 32, with 10 return of symptoms (31.2 per cent.).

Calculous cholecystectomies 24, with 8 return of symptoms (33 $\frac{1}{3}$  per cent.).

Non-calculous cholecystectomies 8, with 2 return of symptoms (25 per cent.).

The 13 per cent. higher return of symptoms following cholecystostomy as compared to cholecystectomy may be due to the fact that cholecystostomy (during these years 1910-1920) was more often performed in the advanced complicated and usually calculous cases, the return being twice as frequent in calculous as non-calculous cases. While after cholecystectomy, in presumably less complicated or earlier cases, the difference between the two types of disease is much less, only 8 per cent.

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Of the 40 cases known to have return of symptoms, in 15 the symptoms subsided spontaneously, and 7 were relieved after secondary operation. In a consideration of spontaneous subsidence of symptoms one must realize that in *recent* cases a remission of symptoms would be of little importance—

as it is a well-known fact that symptoms of biliary tract disease are often absent or misinterpreted. Cases with known gall-stones often defy diagnosis between attacks of colic, though a properly developed history will usually bring out a story of "dyspepsia", "indigestion", "gas" with qualitative food distress. Long intervals between attacks of symptoms are not rare and are often attributed to the administration of some medicine or operation.

In these 15 cases of spontaneous subsidence of symptoms, the gall-bladder remains in 11 and has been removed in 4; the time of return of symptoms after operation was, first year in 11; fifth year in 1; sixth year in 2; seventh year in 1. The duration of symptoms was one year in 8; two years in 4; and three years in 3.

Of the 14 secondary operations death followed in 3, relief of symptoms was secured in 7, and symptoms persisted in 4. The deaths were in the following cases:

1. Previous operation, cholecystostomy for acute calculous cholecystitis and cholangitis; at second operation, six weeks later, for continuation of same symptoms and increasing jaundice (thought to be due to stone in common duct), the common duct was opened and drained, no calculi nor obstruction was discovered.

2. Previous operation, cholecystostomy, for chronic calculous cholecystitis, followed by satisfactory recovery; but two years later a mass developed at the site of the operation; secondary operation revealed carcinoma, primary of the gall-bladder, at the site of previous cholecystostomy.

3. Previous operation, cholecystostomy, for chronic calculous cholecystitis and cardiospasm, which was followed by relief of symptoms for one and a half years and then by a recurrence of gastric symptoms. Secondary operation was gastrostomy for carcinoma of cardia. (The relationship between cholelithiasis and cardiospasm is not uncommon.)

Relief of symptoms followed secondary operations in seven cases.

1. Primary operation, cholecystostomy, non-calculous. Second operation, gastro-enterostomy for pyloric obstruction due to adhesions.

2. Primary operation, cholecystostomy, calculous. Second operation, drainage of pancreatic cyst.

3. Primary operation, cholecystostomy, non-calculous. Second operation, cholecystectomy, non-calculous.

4. Primary operation, cholecystostomy, non-calculous. Second operation, cholecystectomy, non-calculous.

5. Primary operation, cholecystostomy, calculous. Second operation, cholecystectomy, calculous.

6. Primary operation, cholecystostomy, calculous. Second operation, cholecystectomy, calculous.

7. Primary operation, cholecystectomy, calculous. Second operation, drainage of common duct, non-calculous, no obstruction.

The symptoms persisted after second operation in four cases.

1. Previous operation, cholecystostomy, calculous. Secondary operation, cholecystectomy, calculous.

2. Previous operation, cholecystostomy, calculous. Second operation, cholecystectomy, calculous.

3. Previous operation, cholecystostomy, calculous. Second operation, cholecystectomy, non-calculous, and drainage of common duct, non-calculous.

4. Previous operation, cholecystostomy, non-calculous. Second operation, cholecystostomy, non-calculous.

A review of the 14 secondary operations shows:

Primary operation was calculous in 12 and non-calculous in 2.

Primary operation was calculous and secondary operation non-calculous in 8: 1 common duct, death; 2 common duct, relief; 1 primary cancer of gall-bladder, death; 1 cancer of stomach, cardia, death; 1 pancreatic cyst, drain relief; 2 cholecystectomies, relief.

Primary operation was calculous and secondary operation calculous in 4 cholecystectomies, 2 relief and 2 no relief.

Primary operation was non-calculous and secondary non-calculous in 2: 1 gastro-enterostomy and cholecystostomy and 1 cholecystostomy repeated, 1 relief and 1 no relief.

Primary operation was non-calculous in 2, and secondary calculous in none.

Gall-bladder remains in 1 of 4 that were not relieved by second operation.

Gall-bladder remains in 2 of 7 that were relieved by second operation.

The 8 cases in which gall-stones were present at the primary operation and were absent at the secondary operation, in conjunction with numerous cases of this finding since 1920, calls attention to non-calculous intermittent biliary obstruction following cholecystectomy and the possible and probable influence of pancreatitis, hepatitis, duodenal ulcer or duodenitis and retro-peritoneal changes, as a cause of a return of symptoms.

Consideration of the 15 cases with persisting symptoms shows that the gall-bladder remains in 7 and has been removed in 8.

In 12 there were calculi, 6 cholecystostomies, and 6 cholecystectomies.

In 3 there were no calculi, 1 cholecystectomy and 2 cholecystostomies.

The symptoms complained of were "dyspepsia, indigestion," without colics in 4; with colics in 11.

The designation "neurotic" and "enteroptotic" was applied to 4.

Return of symptoms coincided with pregnancy in 1, cholecystostomy.

In 2 cases of cholecystectomy for calculi, Wassermann was 4 plus.

The appendix had been removed in all of this group of cases and in 7 cases pelvic operations had also been performed.

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There were 15 females of the following ages: 29-30, 1; 30-40, 4; 40-50, 5; 50-60, 4; 60-70, 1.

Definite conclusions may not be drawn from such a review of so small a number of cases, the possible errors are too numerous, for example: In the calculous cases there is always the possibility of overlooked stones and of coincident disease, while in the non-calculous cases the chance of mistaken diagnosis is greater and the existence of intercurrent disease is, of course, the same.

Having demonstrated that unsatisfactory results, *i.e.*, return of symptoms follow gall-bladder operation, drainage or removal for calculous or non-calculous cholecystitis, the next question is what is the cause?

Among the many causes for return of symptoms one may mention: (1) Mistaken diagnosis; (2) surgical accidents; (3) incomplete operation; (4) coincident or resultant disease.

1. Mistaken diagnoses: Gall-bladder disease may be simulated by a multitude of conditions, among the more common are the following: (a) Diseased appendix, not removed; (b) gastro-intestinal ulcer or malignancy; (c) Renal calculi or disease; (d) cardiac disease; (e) pulmonary disease; (f) lues or other nervous disease.

(a) A diseased appendix is rarely overlooked or allowed to remain as a source of symptoms after gall-bladder operation; in this day of aggressive surgery one might say that even a normal appendix is rarely overlooked or allowed to remain.

(b) Duodenal or gastric ulcers, small ones, on the posterior wall, or mucous erosions may certainly be overlooked, such ulcerations or malignancies are often coincident with biliary tract disease.

One must not be lured into a sense of false security by the gratifying discovery of gall-stones that confirms a pre-operative diagnosis. The adjacent viscera must be carefully examined as the coincidence of gall-stones with other disease is not uncommon. For example, in 1922 I made a diagnosis of gastric ulcer in a doctor of fifty-four years of age; he was soon operated upon, gall-stones were removed which was followed by a return of symptoms and in 1927 the patient died of cancer of the stomach.

(c), (d), and (e). The *acute* colic referred to the abdomen from the heart, angina pectoris; lung, pneumonia; kidney, renal colic; is a well-recognized clinical phenomenon; but it is not as well recognized that *chronic* disease of these extra-abdominal viscera may likewise cause chronic or sub-acute pain or distress in the upper abdomen which may be misinterpreted as biliary tract disease.

(f) Gastric crises of tabes is often overlooked as a cause of abdominal pain. In two of this series, gastric crises caused symptoms to persist after removal of calculi and gall-bladder.

Intercostal neuralgia has been recognized as a simulator of gall-bladder disease.

A frequent mistake is that in which the gall-bladder is normal, but is drained or removed under the impression that it is causing the symptoms.

The teaching that "gas on the stomach" with qualitative food intolerance justifies the diagnosis of cholecystitis and cholecystectomy as treatment, wonderfully simplifies the practice of medicine, but calls for careful scrutiny of *end* results, before it can be accepted.

Under the heading of mistaken diagnoses, one must consider the question, what constitutes a normal gall-bladder and how is it to be recognized? Quite a question when one realizes that it has not been answered entirely satisfactorily in connection with as accessible and visible a structure as the tonsil.

A gall-bladder may be abnormal and produce no clinical symptoms and per contra, the symptoms of cholecystitis may exist with a normal gall-bladder.

A gall-bladder may be normal to palpation and inspection, but show pathology after it is opened; and the gall-bladder that seems normal to the naked eye may prove to be pathologic, under the microscope.

Sterile bile does not necessarily mean normal gall-bladder wall.

So it would seem in this matter of correct diagnosis that one is "between the devil and the deep blue sea". If one operates upon clinical symptoms only, with usual signs of pathology absent, one is in danger of performing an unnecessary, therefore harmful operation, *i.e.*, removal of a normal gall-bladder. Or if one awaits the development of positive gross evidence of pathology in or around the gall-bladder, there is danger of intercurrent or resultant pathology in neighboring viscera having become established, with a consequent diminished chance of permanent cure.

(2) Surgical accidents: Damage to liver, pancreas, duodenum or common duct are uncommon, but injury to common duct is perhaps more frequently undetected at time of operation.

(3) Incomplete operation, stone remaining in ducts or portion of gall-bladder or cystic duct remaining, may of course cause a continuation or recurrence of symptoms.

Overlooked calculi or recurrence of calculi does not seem to be responsible for a large number of recurrences. For instance, Judd and Burden failed to find calculi in 24 secondary operations upon the common duct. In this series the common duct was explored in 3 of the secondary operations and no calculi were found. In 12 cases of primary operation for calculi, at 8 secondary operations no calculi were found.

It would seem reasonable to conclude that the most usual cause of return or continuation of symptoms *after* operation are the same factors that frequently cause a return or continuation of symptoms *before* operation, namely disease in viscera other than the gall-bladder.

(4) Coincident or resultant disease:

Extension of disease from the gall-bladder and the extrahepatic ducts to the intrahepatic ducts and the liver, with perhaps, biliary cirrhosis, is a logical sequence. Cirrhosis of the portal type may be coincidental. Acute

pancreatitis is often an extension of biliary tract disease, and the chronic type has been demonstrated as a sequence and may cause persistent symptoms. In this series the pancreas was diseased in 42 cases (22.5 per cent.) in 4 carcinomas; in 9 acute pancreatitis; in 29 chronic pancreatitis, interstitial or lymphatic. Gastritis as evidenced by hypo- or achlorhydria is a recognized sequence of gall-bladder disease. So-called colitis is often a coincidence, if not a causative or resultant factor in biliary tract disease. The relationship between cholecystitis and myocarditis has been suspected as being a causal one. Gastric or duodenal ulcer or appendicitis are not infrequently coincidental with possible causative relationships. An infected gall-bladder may act as a focus of infection with the usual secondary manifestations.

Post-operative adhesions are, of course, always present, but in rare instances they may cause crippling deformities that interfere with function in neighboring hollow viscera and thereby cause post-operative symptoms.

In order to reduce the percentage of unsatisfactory results it must be recognized that surgery is a means to an end and not an end in itself. Cholecystostomy, cholecystectomy or choledochotomy may save life, but in many cases gall-stones are merely an incident in the course of cholecystitis and cholecystitis is often merely an incident in a biliary tract disease, that calls for medical management before and after drainage or removal of the gall-bladder; once again demonstrating the need of coöperation between the physician and the surgeon; and that the surgeon, unless he degenerates into a mere technician, must be a physician who operates.

## NON-PARASITIC CYSTS OF THE LIVER<sup>1</sup>

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CYSTS are an interesting group of tumors and a study of their origin opens an attractive field for speculation. One group of cysts is formed by the persistence of fetal structures. Inclusion of embryonic or adult cell groups produces certain types. Occlusion of ducts by faulty development or by fetal or extrauterine neoplastic or inflammatory processes explains the origin of others. Hemorrhage, especially that into parenchymatous organs or vascular tumors may result in cyst formation during the organization of the clot. Obstruction of lymphatic channels or spaces leads to their cystic dilatation. Degeneration involving the tissues or the structure of solid tumors is responsible for cystic changes in various parts of the body. Certain types of neoplastic growths are cystic in their ordinary development.

Parasitic cysts are special forms of reaction to invasion by certain organisms. The late Doctor Thompson in an address before the Southern Surgical Association in 1919 showed how cysts developing from embryonic inclusions or remnants may be carried far from the seat of their origin by the growth of the normal structures.

Non-parasitic cysts of the liver may be single or multiple. Multiple cysts may be limited to the liver, or may be associated with cysts of the kidneys, the pancreas or other abdominal organs. In many cases patients suffering from this polycystic disease show external evidences of defects in development, such as cleft palate, polydactylism, meningocele, etc.

The single cysts appear to be developed from aberrant bile ducts or to be cystic adenomata developed from the same source. The wall of these cysts is lined either entirely or in part by epithelium of the same type as that lining the normal bile ducts modified by the size of the cysts.

Ordinarily there is no evidence of the formation of secreting epithelium. As a rule the cysts do not communicate with the biliary tract, and the contents rarely contain bile. Of sixty-three cases studied by J. F. X. Jones,<sup>2</sup> only four are reported to have contained fluid resembling bile. In one of these four the operator's diagnosis was congenital dilation of the gall-bladder and of the common duct.

If these cysts are primarily cystic adenomata, secreting epithelium of an embryonic type at some time formed part of their structure. The duct channels being imperfectly developed and closed, an accumulation of secretion takes place within the confines of the tumor, producing the cyst.

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<sup>1</sup> Read before the Southern Surgical Association at Augusta, Ga., 1927.

<sup>2</sup> ANNALS OF SURGERY, January, 1923, vol. lxxvii, p. 68.



# ABDOMINAL INCISIONS\*

THEIR MAKING AND CLOSURE

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MOYNIHAN says: "I do not think, though much has been written, it is adequately recognized that the steps in the making and in the repair of the abdominal wound are of the very greatest importance. I doubt if it is an

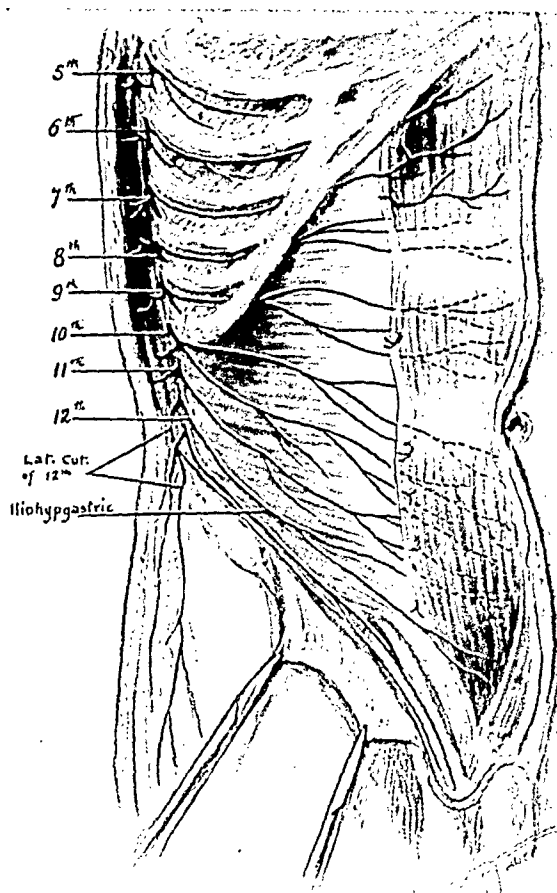


FIG. 1.—Showing nerve supply of muscles of abdominal wall.

exaggeration to say that the circumstances connected with the incision are among the most important in the whole range of abdominal surgery. For, if the incision be improperly made, by free division of muscle fibres and the wilful and unnecessary severing of nerve trunks, a weakened area is left in the belly wall, the result of which may be of even greater severity than the condition which first made operation advisable. Too great care therefore cannot be exercised in the proper choice of a method of incision and of the means of its securest closure. It is a cardinal rule that there shall be no division of muscle fibres unless it is absolutely necessary for a sufficient exposure of the operation field; muscle fibres are to be displaced or separated without injury to nerve supply, never to be cut."

I have for some years past been interested in the defects of the abdominal wall, the result of operative incisions, and after observing a goodly number of cases from other clinics I am of the opinion that there is a general tendency to disregard this step in abdominal surgery. By observing a few simple rules it is possible to leave the abdominal wall as strong and free of defects as it was before operation. There are instances, more especially in cases of malignancy, when the operator is justified in sacrificing the structure of the abdominal wall in order to give sufficient exposure. But it is the usual case to which I refer and not these exceptions.

\* Read before the Philadelphia Academy of Surgery, October 10, 1927.

The secretion of imperfect cells is not likely to be true bile. It accumulates under varying degrees of tension, and is subject to chemical changes during the period of accumulation and retention within the cyst cavity. Such physical and chemical action has a marked influence on the structure of the cyst wall, on the nature of its contents, and on the relations of the cavity to the adjacent normal liver. When a flow of bile occurred during the course of healing after marsupialization and drainage, as in the case reported by Maes,<sup>3</sup> the cysts all seem to have been large central ones, where the probability of rupture of a duct into the cavity could explain the flow of bile into the drainage tract. The changes mentioned above show the impracticability of determining the exact origin of these large solitary cysts by a study of the structure of the wall or the chemical composition of the contents.

Multiple cysts of the liver may be the result of similar occlusion of aberrant bile ducts. The diffuse involvement of the liver makes it unlikely that they are cystic adenomata. The association of multiple cysts of the pancreas may be explained by their similarity in origin, both organs developing from buds on the embryonic duodenum.

It is more difficult to explain the frequent association of congenital polycystic disease of the kidney with multiple cysts of the liver. The most generally accepted theory regarding the cause of the kidney disease attributes it to a developmental error in the fusion of the embryonic kidney, which leaves certain glomeruli and secreting tubules ununited to the corresponding excretory tubules. As the secretion collects in these occluded areas, cysts of various size and shape are formed.

Except for the fact that multiple congenital defects are common, there is no reasonable explanation for the simultaneous occurrence of such a mishap in the embryonic kidney and the development of aberrant bile ducts in the liver.

Carling and Hicks<sup>4</sup> believe that these polycystic lesions are formed from inclusion of isolated portions of the Wolffian body in the enteric buds forming the liver and pancreas and in that part of the intermediate cell mass in which the secreting portion of the kidney is developed.

Most solitary cysts are found growing from the under surface of the liver, extending to the anterior border in the region of the gall-bladder fossa. Teuscher<sup>5</sup> states that the developmental anomaly producing liver cysts involves more especially the embryonic plexus like hepatic ducts at the hilum.

A number of cases are reported in which the cyst occurred in the central areas of the liver, and presented on either the superior or inferior surface. Several cysts appeared as pedunculated tumors growing from the surface or margin of the liver. The central cysts usually are surrounded by a zone of fibrosed liver tissue. Atypical lobulation of the liver may be the result of pressure of a large cyst or may be an evidence of congenital malformation.

The condition is more common in females, the proportion of incidence

<sup>3</sup> American Journal of Surgery, March, 1924, vol. xxxviii, p. 68.

<sup>4</sup> British Journal of Surgery, October, 1925, vol. xiii, p. 238.

<sup>5</sup> Archives of Pathology and Laboratory Medicine, April, 1927, vol. iii, p. 706.

between the sexes being about 4 to 1. Most of the patients are between forty and sixty years of age, although there are cases reported occurring in newborn children and in septuagenarians. External violence is mentioned in a few cases as a possible cause, but no proof is offered to show that trauma is a factor in the production of the cyst.

Clinically, solitary non-parasitic cysts of the liver have no signs or symptoms sufficiently characteristic to make a pre-operative diagnosis certain. They have been found when the abdomen was opened for exploration, or for the relief of symptoms interpreted as chronic cholecystitis, hydronephrosis, mesenteric cyst, ovarian cyst, tuberculous peritonitis and other lesions. When the diagnosis has been made as in the three cases from the Mayo Clinic included in Jones' report, they were large cysts recognized as tumors growing from the liver.

Many of these cysts grow in the neighborhood of the gall-bladder fossa and give rise to pressure on the gall-bladder or the extra-hepatic ducts. This pressure may explain the jaundice occasionally met with in connection with the cysts. It is probably responsible for the symptoms like those of cholecystitis which are so often noted, and may be the cause of the coincident evidences of chronic inflammation found in the gall-bladder and ducts.

Examination by means of the X-ray may show the relation of the abdominal tumor to the liver, and thereby aid in the differentiation from ovarian and other cysts. Calcareous deposits are more common in parasitic cysts, but Sharkey<sup>6</sup> reports such areas in the thin wall of a solitary cyst. The shadow of such spots might help in this differentiation. Pneumoperitoneum should make this examination more accurate in its results.

When the physical examination and the history suggest a solitary cyst of the liver, further investigation should be made regarding the probability of echinococcus infection as its cause.

At operation it is necessary to distinguish the simple cyst from the parasitic one, and from cystic dilatation or diverticulum of the extra-hepatic bile ducts. The last-mentioned lesion is recognized by its anatomical relations and is treated by making an anastomosis between the dilated duct and the gastrointestinal tract. The typical hydatid cyst has a laminated outer capsule or adventitia and an inner membrane which carries the daughter cysts, while the simple cyst has a thin single wall.

Solitary cysts are treated by excision, complete or partial, or by drainage with or without marsupialization.

The following is an abstract of the record of a personal case of solitary non-parasitic cyst of the liver.

CASE REPORT.—S-47974. The patient, a white matron, age thirty, was admitted to the Mercy Hospital, May 10, 1926, with a diagnosis of chronic cholecystitis. The diagnosis was made by her physician, Dr. Wilbur Pearce, and I concurred in its correctness. For more than a year she had suffered from recurrent attacks of pain in the upper right quadrant of the abdomen. The pain radiated to the back and to the right shoulder. With

<sup>6</sup> Trans. London Patholog. Soc., 1882, vol. xxxiii, p. 168.

## NON-PARASITIC CYSTS OF THE LIVER

each attack there was vomiting, and more or less indigestion was present between them. There was no history of jaundice. Since the last attack, ten days before admission, an indefinite but apparently smooth rounded mass could be felt at the margin of the liver and was taken to be a distended gall-bladder. This area was tender and there was some muscle spasm present.

At operation we found a cystic tumor growing from the lower surface of the liver and extending a short distance beyond its anterior margin. The tumor was thin-walled, lobulated and sausage-shaped, about 9 inches in its long and  $2\frac{1}{2}$  in its transverse diameter. The omentum was adherent to it at several points. The cyst was situated just to the left of the gall-bladder, but was not attached to this organ or to its ducts. There were no evidences of disease of the bile tract.

Aspiration drew out about 700 c.c. of clear straw-colored fluid which did not stain the gauze packs. After the cyst was empty we found that part of the wall was so intimately blended with the liver substance that no line of separation could be discovered. For this reason the greater portion of the wall was excised, leaving a sufficient amount to suture into a narrow tube, the inner side of which included the attachment to the liver. This tube was packed with iodoform gauze and brought up to, but not sutured to the peritoneum. The abdominal wall was closed around the protruding pack.

The patient recovered without any complications. A small amount of fluid which scarcely stained the dressings drained out for the first week. The iodoform pack was gradually removed, the last part coming out on the tenth day. The wound then healed and the patient was discharged from the hospital twenty-seven days after the operation. She has had no recurrence of abdominal symptoms and is considered cured.

Section of the cyst wall shows fibrous tissue containing many large new blood-vessels, a certain number of bile ducts and an area of liver cells which are entirely surrounded by fibrous tissue and do not appear to connect with any of the ducts.

# PHLEGMONOUS GASTRITIS

OF *BACILLUS AEROGENES CAPSULATUS* (B. WELCHII) ORIGIN

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AND

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PHLEGMONOUS gastritis is in itself of sufficient rarity to always excite comment. The occurrence of the *bacillus aerogenes capsulatus* as the probable etiologic agent or at least as the most prominent factor in the picture has led us to report the following observation.

CASE REPORT.—A rather thin, sallow looking but otherwise healthy man, seventy-two years, had been running an elevator until two days ago, October 23, 1927. At that time he noticed slight discomfort in the stomach but attributed this to overeating. The trouble persisted, however, and at 11 A.M. on October 25 while working was seized with a sudden, severe but not sharply localized pain in the upper part of the abdomen. He was obliged to stop work and was admitted to the Emergency Division. There was no vomiting, although slight nausea was present. On examination, the abdomen was soft. The bowels had moved normally during the morning before the pain came on. He was not considered to be in serious condition and was not seen again till 3 P.M. when he was admitted to the medical service for further study. At 4 P.M. it was apparent that the patient was suffering with a very severe pain in the epigastrium. His temperature was 37.8° C., the pulse rate was 92 and the respirations were 20. General examination showed moderate arteriosclerosis; a few râles at the base of the left lung, a blood pressure of 165 systolic and 100 diastolic; and a normal heart. The abdomen showed the scars of two hernia operations with a slight defect still present on the right. There was acute tenderness over the entire abdomen and a board-like rigidity. The dulness of the liver was at the costal margin at the start of the examination but fifteen minutes later there was tympany replacing the dull area. The count of the white blood-cells showed 17,300. The only point of importance in his past history was two attacks of previous abdominal discomfort never accurately diagnosed. In one of these attacks he was in bed six weeks.

A diagnosis of acute perforated ulcer was made. Exploratory operation was carried out under nitrous oxide anæsthesia. Upon opening the peritoneum a fluid with greenish undigested food particles was encountered and a few bubbles of gas escaped. A perforation 1 cm. in diameter was found on the anterior surface of the duodenum just beyond the pylorus. A few recent adhesions were also present. A non-indurated ulcer was excised by the Heineke-Mikulicz procedure and closure was made without drainage. The patient did not react well to his anæsthesia and was in poor condition on leaving the operating room. His pulse was rapid and feeble; his blood pressure had dropped to 100 systolic and 80 diastolic, and was fluctuating; and he was very pallid. He rallied under hypodermoclysis and rectal fluids and was in fairly good condition the next morning. Culture of the fluid obtained from the peritoneum at operation showed no growth.

He continued to improve slowly for five days till November 1, 1927, although he differed from the average perforated ulcer patient in repeatedly vomiting small amounts of "coffee ground" material and in running a pulse rate at 120 per minute. On November

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1, 1927, an area of relative dullness was found at the base of the left lung posteriorly extending upward to the angle of the scapula. The breath sounds were unchanged in this area but there were fine crackling râles present. Röntgen-ray pictures suggested consolidation in the left lower lung field with the question of fluid as well. The abdomen was considerably distended, tympanitic throughout and held fairly rigidly. The white blood count was 18,500. He was irrational through the day. The temperature rose to  $37.6^{\circ}\text{C}$ .; whereas it had been normal or subnormal up to this time, and his respirations were rapid and shallow at 34 per minute.

Pylorus→



FIG. 1.—Photograph taken from colored drawing. It shows thickened and oedematous mucosa studded with gas bubbles.

A Levene tube was introduced into the stomach on account of the vomiting and 1000 c.c. of dark brown fluid recovered. An additional 2000 c.c. drained into the bottle from this tube during the night. The material did not have a fecal odor. The following morning the vital signs showed little change except that the pulse was feeble and obtained at the wrist with difficulty. He was evidently in extreme distress due to embarrassment in respiratory exchange and incessant retching. He gradually grew worse during the morning: the blood pressure could not be recorded; he became pulseless; the skin over the entire body was cold, ashy gray and clammy. He remained conscious though irrational for two hours after this marked picture of shock had appeared. Then he vomited suddenly nearly 1000 c.c. of bright red fluid and died immediately thereafter.

At post-mortem examination within one hour of his death, the peritoneal cavity contained about 500 c.c. of clear serous fluid of yellowish tinge. There were old adhesions about the appendix region and fresh easily separated adhesions about the transverse colon, stomach and gall-bladder. Each pleural cavity contained about 2000 c.c. of straw-colored fluid. The heart was normal except for myocardial scarring and advanced sclerosis. The lungs showed hypostatic congestion and oedema but there were no patches of pneumonia. The pyloric end of the stomach was covered with omentum

which had been sutured in place. On stripping away the omentum a line of silk sutures with no obvious inflammation about them was exposed. The stomach did not present anything unusual from its external surface. The mucosa of the lower 10 cm. of the œsophagus was boggy, blood stained, and acutely inflamed. The stomach contained considerable brick-colored blood mixed with mucus and food material. The mucosa was thickened and œdematous; it was dark reddish-brown in color; it contained bright red extravasated blood and was studded with gas bubbles about the size of a pin head. The rugæ were prominent on account of the infiltration with inflammatory exudate. The mucosa underlying the sutures was gray and necrotic over an area of 2 cm. No definite source of hemorrhage was found. Cultures were made from the underlying tissue. The stomach wall appeared to be about 1 cm. in thickness in contrast to the average. The entire stomach, lower 10 cm. of the œsophagus and upper 10 cm. of the duodenum was involved in the picture but no gas bubbles were present in the œsophagus or duodenum. (Fig. 1.) The remainder of the gastro-intestinal tract was negative. There was no evidence of gas bacillus infection in any other portion of the body, indicating that this was a localized process and not part of a general terminal gas bacillus invasion. Aside from arteriosclerosis nothing else of importance was noted.

Microscopic picture through the fundus of the stomach showed the mucosa diffusely infiltrated with mono and polymorphonuclear cells, the former predominating. The submucosa was approximately five times its usual thickness. There were occasional polymorphonuclear and lymphoid cells in both the submucosa and muscularis. The gas bubbles were present in the mucosa, muscularis mucosa and submucosa especially, but not in the muscularis or serosa. (Figs. 2 and 3.) Numerous bacteria were also noted in the submucosa, the predominating organism being a large, blunt, Gram-positive bacillus.

Sections through the operative area at the pylorus showed that part of the mucosa was necrotic. The submucosa was not as greatly distended as in the fundus but contained many more pus cells. The muscularis was also acutely inflamed and partially destroyed by abscess formation. Both sections included thrombosed veins. The microscopic picture of gas bacillus infection was not found in any other organ.

*Bacteriology.*—Direct smears taken at post-mortem from the stomach wall after cutting through the mucosa showed numerous Gram-positive bacilli and in places chains of cocci. (Figs. 4 and 5.) Anaërobic culture in deep litmus milk showed acid reaction and stormy fermentation characteristic of *B. Welchii*. In deep meat broth there was a turbid growth with considerable gas production. The Bacteriological Department considered that further tests were not necessary to establish the identity of the suspected organism so that serologic examination and animal inoculation were not carried out.

This man at first did not seem to react differently from the usual post-operative perforated ulcer patient. Recovery was not as rapid or as marked but it was thought that his age and general condition were responsible. Small quantities of "coffee ground" material were vomited daily post-operatively so that hemorrhage from one of the gastric vessels was suspected. Clinical evidence of a severe blood loss was not obtained, however, and expectant treatment was accordingly adopted. The picture changed decidedly for the worse five days after the onset but enough signs were found in the chest to account for it. At this time the condition was such as one finds in a severe toxæmia, and almost identical in retrospect with the rather common war toxæmia associated with gas gangrene. The accumulation of fluid in the stomach indicated a disturbed motor or secretory function of this organ but the character of the vomitus gave no evidence of a bowel obstruction below. The invasion of the stomach by the Welch bacillus was not suspected clin-

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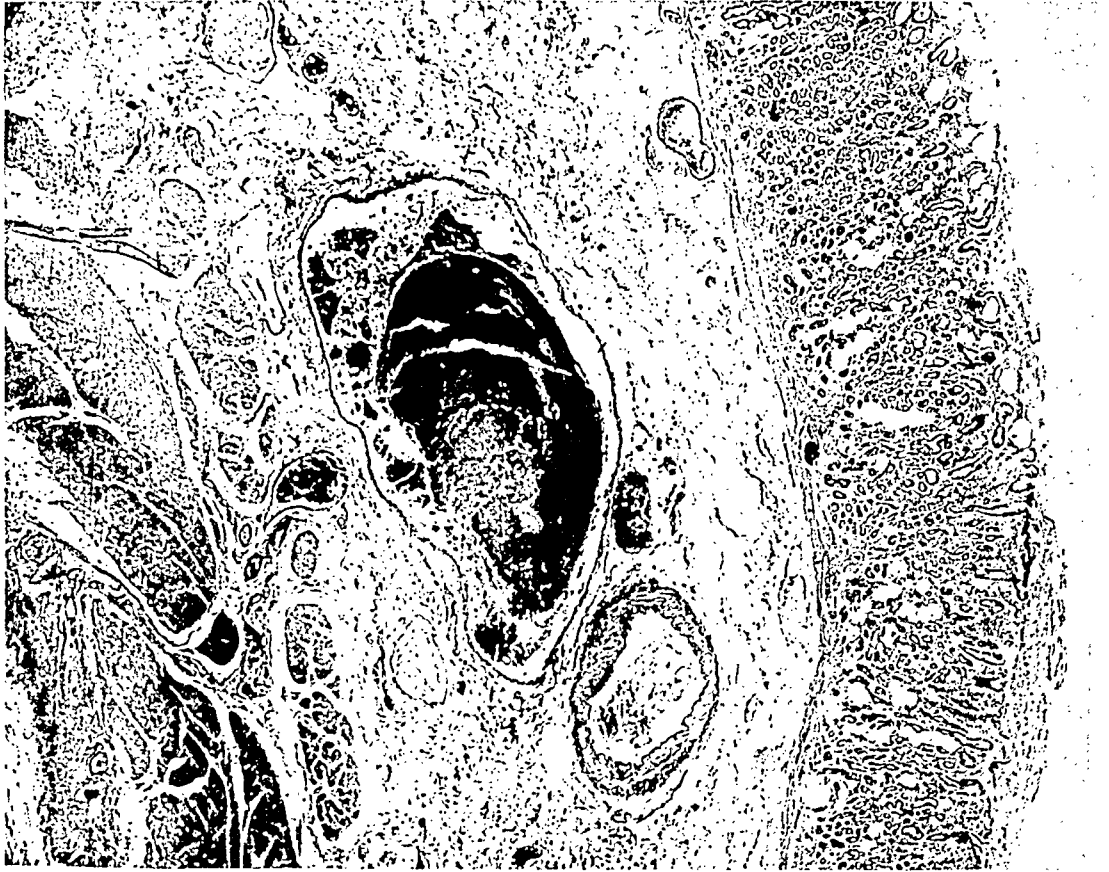


FIG. 2.—Microphotograph of section through the wall of the stomach. ( $\times 10$ .) The gas bubbles show very plainly in the mucosa, muscularis mucosa and less well in the submucous layer through lack of contrast. The muscular layers are not involved. A large thrombosed vein is present in the centre of the microphotograph.

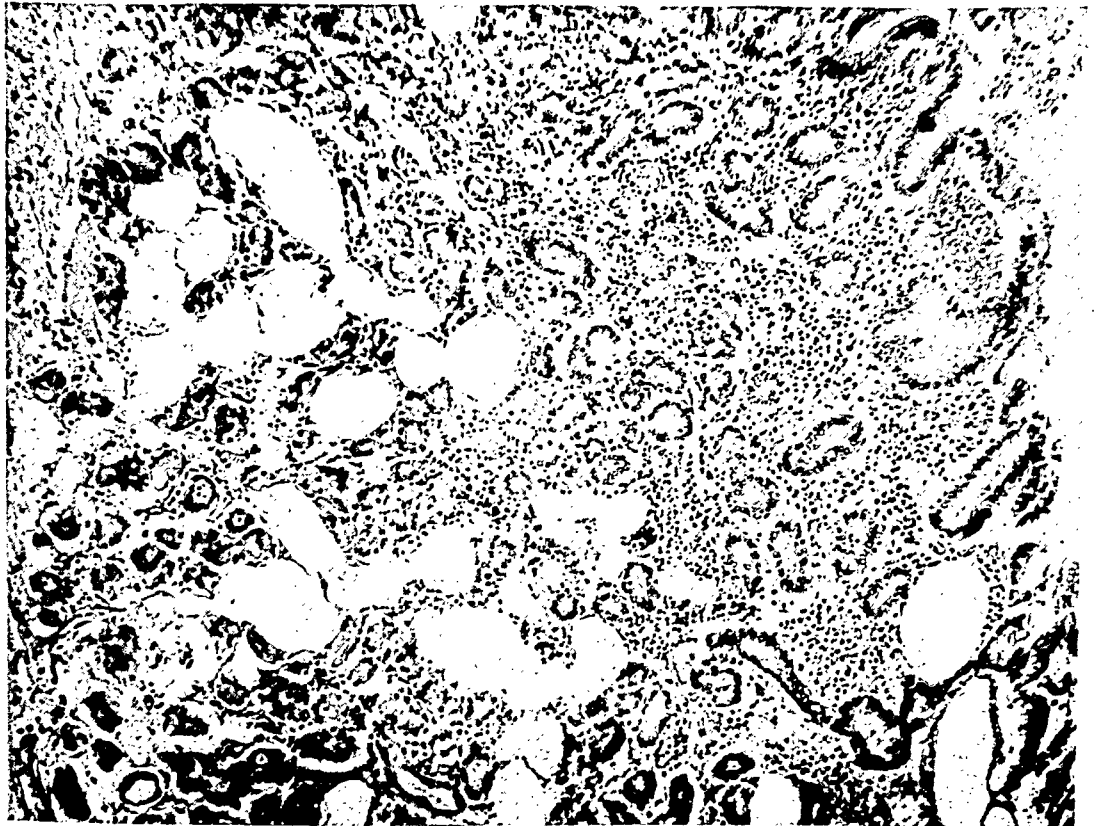


FIG. 3.—Higher magnification. ( $\times 96$ .) The section consists mainly of mucosa with contained air bubbles.



ically although it probably occurred at least from twenty-four to thirty-six hours before death and perhaps even earlier. The probable portal of entry was in the necrotic area about the suture line. The suture line itself was intact with no evidence of leakage or peritonitis.

There is quite an extensive literature dealing with phlegmonous gastritis. Lawrence,<sup>1</sup> who has reviewed the subject thoroughly, says that up to the time of his report there were but two hundred and thirty-seven cases recorded. He added two other case reports. In summarizing the etiology, he found the streptococcus group to be the most common causative agents; occasionally also staphylococci and rarely pneumococci were responsible. Sometimes one of these organisms occurred in a mixed infection with *B. coli* and *B. subtilis*. In no instance, as far as we are aware, has the *B. aerogenes capsulatus* played a rôle either as the primary cause or as a secondary invader.

It seems rather strange, in view of the prevalence of the Welch bacillus as an inhabitant of the big bowel of man, that infection with this organism takes place so rarely. In the presence of trauma, ulcerations, surgical interventions, etc., ample opportunity would be provided for invasion with this bacillus. Apparently usually the local conditions are not favorable for the lodgement or propagation of this organism even in the large intestine. Normally the lower part of the small intestine contains a very active bacterial flora, whereas the stomach and upper intestine are relatively sterile. This was shown by Cushing and Livingood<sup>2</sup> in a careful study. It has only recently been demonstrated that under altered physiological or pathological conditions, invasion of the whole gastro-intestinal tract is possible (Meleney, Jobling and Berg<sup>3</sup>; MacNeal and Chace<sup>4</sup>; Gorke<sup>5</sup>). We have personally recovered *B. Welchii* repeatedly from high jejunostomy loops in patients suffering from obstruction or ileus due to any cause.

The gastro-intestinal tract, however, is not entirely immune to the invasion and attack of the *B. Welchii*. Deutsch<sup>6</sup> reported a case of gas gangrene of the right arm with the portal of entry through the oral mucosa about an ulcerated tooth. The organism has also been recorded in various parts of the body (Greeley<sup>7</sup>), who reports two cases of cholecystitis due to *B. Welchii*. Gould and Whitby<sup>8</sup> likewise reported a case of cholecystitis due to this organism. Mix<sup>9</sup> presented a very complicated picture of a persistent fecal fistula following appendectomy. He believed it to be due to *B. Welchii*. It was successfully treated by withdrawal of carbohydrates.

Typhoid fever has been complicated by Welch bacillus infection in nine instances according to Muller and Lincoln.<sup>10</sup> In one group there was no perforation but a general *B. Welchii* infection by invasion through the ulcers; in a second group there was a perforation of the ulcer and gas bacillus in the peritoneal exudate but no visceral involvement. Case VIII (Howard) comes the closest to duplicating ours because a gastric ulcer served as the probable portal of entry.

In the pathological picture of phlegmonous gastritis the process appears to be chiefly limited to the submucosa. In our case, the gas bubbles indicate

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Fig. 4.—The characteristic blunt Gram-positive short rods of the *B. Welchii* present in a stained smear preparation made from the submucous layer. (x 56.)

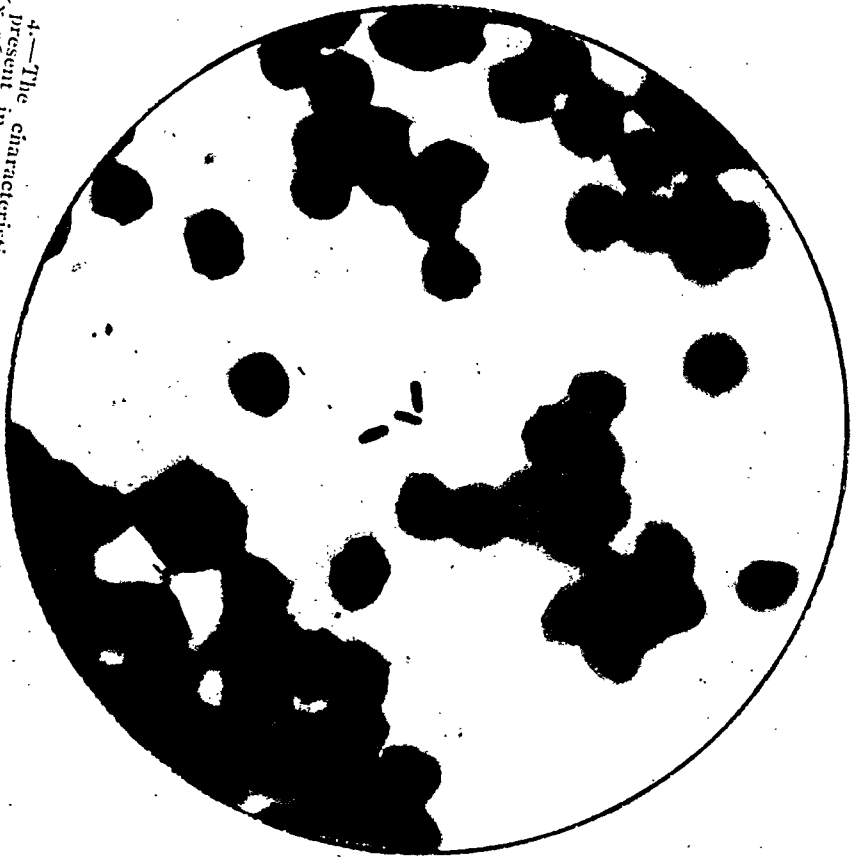
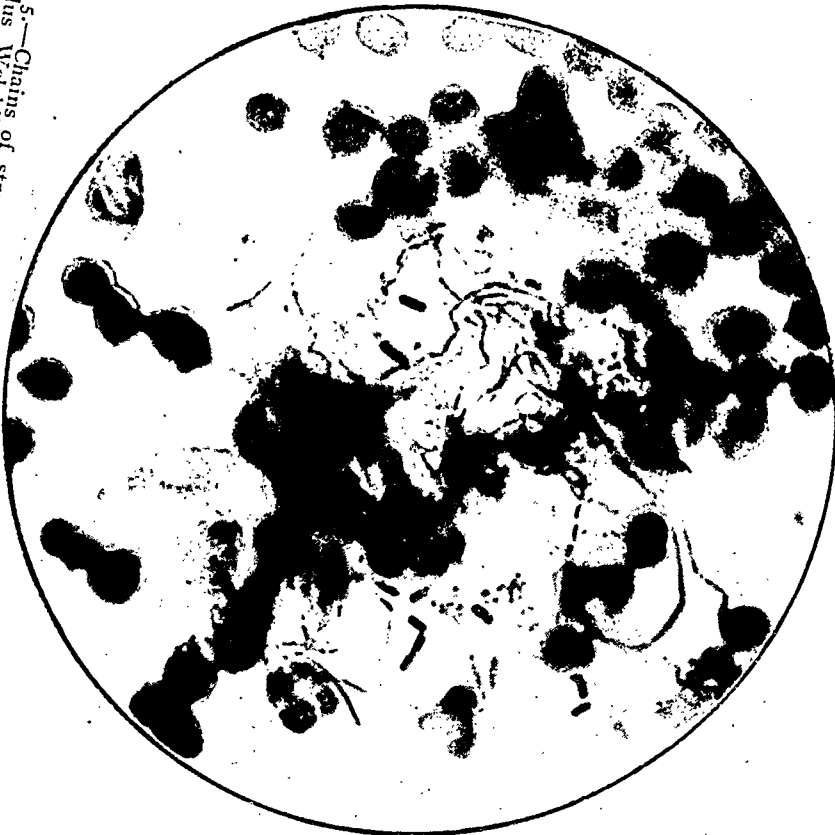


Fig. 5.—Chains of streptococci and other organisms as well as abundance of *Bacillus Welchii* rods from a stained smear preparation made near the suture line. (x 56.)



a marked submucosal involvement but the mucosa also shows much damage. The muscular coats which one would presume to be especially susceptible, seem to have escaped entirely.

The gastric tissues show large numbers of bacilli with the morphological characteristics of *B. Welchii*. In the region of the gangrenous patch there were numerous chains of streptococci as well. We believe that these organisms represent the secondary invaders in this case and that the predominant element in the production of this phlegmonous gastritis was the Welch bacillus.

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It does not seem necessary to go into the detailed anatomy of the abdominal wall for we are all familiar with it, but let us consider briefly the structures which concern us most in the making of an incision. Namely, the muscles, the blood-vessels and the nerves.

The muscles of the abdomen, the three oblique and the rectus on either side have various functions: support of the abdominal viscera, accessory to respiration, aiding in defecation, micturition, and parturition, flexion and rotation of the pelvis and trunk. It is evident then that injury to any of these muscles brings about a disability which may involve one or all of these functions. The oblique muscles should not be cut across but split in the direction of their fibres. This preserves the nerve supply and does the least injury to the blood-vessels. The recti muscles may be cut across without serious damage if properly repaired afterward. It is seldom necessary to cut these muscles as they can be retracted outwardly or inwardly as the case may be. If these muscles are split in the direction of their fibres that portion mesial to the incision will atrophy, its nerve supply having been destroyed. Assmays investigation proved this to be true and I have confirmed his findings. In 3 cases previously operated at other clinics I found at reoperation that mesial portion had disappeared and was replaced by fibrous tissue.

The main source of blood supply to the abdominal wall is from the lower intercostal arteries, the superior epigastric, the deep epigastric and the deep circumflex iliac. The anastomosis is so free that to cut any of them does not bring serious result, but the injury may lead to infection owing to a lessened blood supply.

The motor nerves (Fig. 1) are of the greatest importance. They are eight in number—sixth to twelfth thoracic inclusive, the iliohypogastric and the ilioinguinal. The thoracic nerves are the ones most commonly injured. They run downward and inward between the internal oblique and transversalis muscles, giving off branches to the oblique muscles and terminating in the rectus muscle on its posterior surface near the outer border. It can readily be seen that any incision running across these nerves will sever them.

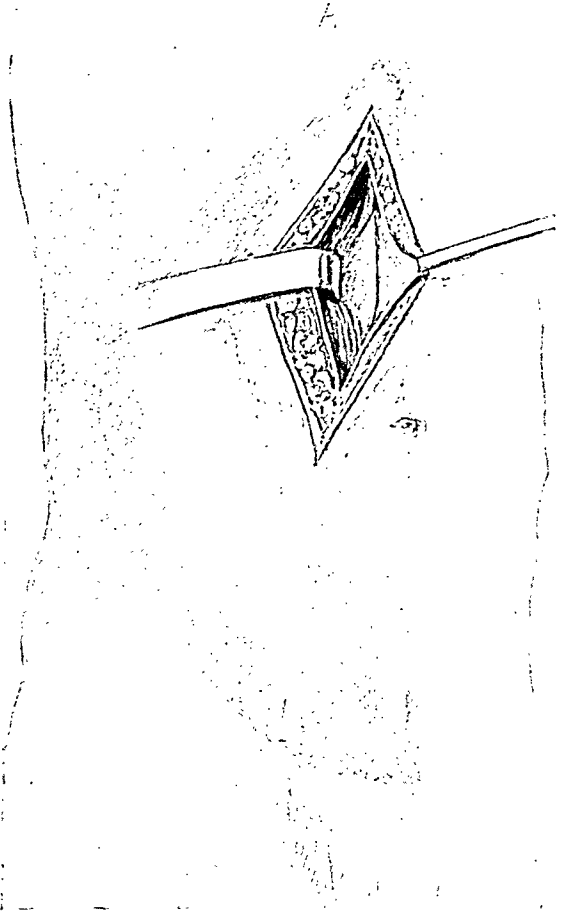


FIG. 2.—Right paramedian epigastric incision, rectus retracted outwardly.

# LATE RESULTS IN PERFORATED GASTRO-DUODENAL ULCERS \*

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MANY articles have been written during the last ten years on the subject of late results following surgical treatment of chronic gastro-duodenal ulcers. On the other hand comparatively few papers have been published on the late results in perforated gastro-duodenal ulcers.

Eliot published in 1912 a very thorough study of immediate and late results following acute perforations of gastro-duodenal ulcers. However, most of the papers written on the subject of acute perforations confine themselves to a discussion of various surgical procedures and an investigation of the operative mortality.

It is stated very often as a positive fact that an acute perforation always leads to a complete healing of the ulcer with a formation of a simple scar. How this process of healing occurs does not seem to be quite clear to most authors. The acute perforation usually takes place in the centre of the ulcer. Although the perforation is only pin-point in size, the ulcer-area often varies from the size of a dime to that of a quarter. In the majority of cases the sutures which close the perforation have to be inserted in the area of acute inflammation. In spite of the fact that the inflamed area is not excised, most authors assume that a spontaneous process of complete healing follows an acute perforation.

One of the well-known procedures in the surgical treatment of chronic gastro-duodenal ulcers is based on the assumption that a spontaneous cure follows an acute perforation. Thus, the perforation is artificially produced by a cautery and the opening closed by sutures.

It seemed advisable to study the late results following acute perforation of gastro-duodenal ulcers with the same care which we used in the study of gastro-jejunal ulcers following gastro-enterostomy. The latter investigation brought to light the interesting fact that, at least in our material, gastro-jejunal ulcers occurred in 34 per cent. of the cases, with 18 per cent. proven by re-operation. The marked difference between this high figure and the usually accepted incidence of gastro-jejunal ulcers (about 5 per cent.) was explained by the fact that we studied our group very thoroughly in the follow-up clinic and did not rely on questionnaires, letters, etc.

In this paper I would like to present our conclusions as to permanent cures following the suture of acute perforated gastro-duodenal ulcers.

Stenbuck in a recent paper reviewed the operative causes of mortality following operations for perforated gastric and duodenal ulcers at Mount Sinai

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\* Read before the New York Surgical Society, February 22, 1928.

Hospital from 1915 to 1925. The mortality was 31 per cent. (twenty-seven deaths among eighty-eight cases).

With his kind permission I have used the same material with the object of getting some definite data as to end-results following operations for perforated gastro-duodenal ulcers.

In compiling these statistical data the same principles were employed as in the previous investigation on gastro-jejunal ulcers. Only those patients were included in this review who presented themselves personally in our follow-up clinic where we were able to study them carefully. As stated above, the only safe follow-up system for tabulating end-results is a thorough personal examination of the patient, with correlation of the X-ray findings and test-meals whenever these investigations are deemed important.

Thirty-three patients operated between 1915 and 1925 on the Surgical Services of Mount Sinai Hospital presented themselves in our return clinic for reëxamination. Years of operation are given in Table I.

TABLE I.  
*Distribution of Cases 1915-1925.*

Year	Number of cases
1915.....	5
1916.....	4
1917.....	2
1918.....	2
1919.....	2
1920.....	3
1921.....	—
1922.....	4
1923.....	6
1924.....	3
1925.....	2

Twenty patients have been perfectly well and free from any gastric symptoms since the closure of the perforation. The perforation was located either at the pylorus or in the duodenum in eighteen cases. An exact differentiation between pyloric or duodenal ulcer is often impossible in acute perforations, as the inflammatory process makes the landmarks (for instance the pyloric vein) practically invisible.

In two cases the perforation was situated near the reëntrant angle.

In ten cases the operation consisted in simple closure of the perforation. In the other ten cases a gastro-enterostomy had been added, with or without pyloric exclusion (Berg's method). In six of these cases a Murphy button had been employed, which was used extensively on this service up to 1920.

Thorough X-ray examinations were performed in a considerable number of this group for two reasons: (1) We feel that in a follow-up clinic radiography ought to be employed freely, as this method gives us a very clear picture of the function of the stomach (size, emptying time, etc.), and (2) We were

## PERFORATED GASTRO-DUODENAL ULCERS

interested to find out whether we could differentiate by an X-ray examination cases in which the ulcer had completely healed from those which were still suffering from a more or less active ulcer.

It seemed possible that the duodenum might show a perfectly normal bulb in those cases in which the ulcer had evidently healed completely. However, Doctor Goldfarb, who studied these groups for me, reports that a deformity of the bulb persists as a result of the layer suture of the perforation even in those cases which have been free from ulcer symptoms since the occurrence of the acute perforation. In other words, in the presence of a previous operation on the pylorus or duodenum a deformed bulb is not a definite indication for the presence of a recurrent ulcer. On the other hand marked tenderness of this region during the fluoroscopic examination, niches and retention, indicate that the patient still suffers from an inflammatory process at or near the pylorus.

I wish to discuss somewhat more in detail the group of failures, comprising thirteen cases. (Table II.)

Eight cases (No. 1, 2, 3, 6, 7, 8, 9, 10) are undoubtedly suffering from a recurrent ulcer. They have the seasonal attacks of epigastric pains, constipation, heartburn and sour eructations. While they have no retention in the stomach, they have to be very careful with their diet. A number of them have not been able to go back to work.

One patient (Case 10) has a pyloric stenosis. He passes the stomach tube every day and obtains a quart of fluid and semi-solid material. We advised re-operation (subtotal gastrectomy) to which he has not consented.

Another patient (Case 4) had three subsequent operations one and two years after the primary perforation. I feel sure that if I had performed a subtotal gastrectomy, when he reentered the hospital the first time following the perforation, this patient would have been cured completely. These operations were performed, before we had instituted subtotal gastrectomy as a method of choice both for gastro-duodenal and gastro-jejunal ulcers.

Case 5 had a suture of the acute perforation with a gastro-enterostomy performed in 1920. He developed a gastro-jejunal ulcer and was operated by another surgeon. Re-operation for recurrent symptoms in 1924 revealed a duodenal ulcer perforated into the pancreas. A partial gastrectomy was performed. He made an uneventful recovery. He did not become anacid. He has the clinical and radiographic evidences of a gastro-jejunal ulcer. This patient belongs to the very rare group of a re-formation of an ulcer after resection of the stomach.

Two cases (11 and 13) in which a simple closure of the perforation had been performed one year previously, came to re-operation on account of the severity of recurrent symptoms. In the first case, two ulcers were found, one at the site of the old perforation and another (kissing ulcer) on the posterior wall of the duodenum. In the other case (No. 13) the perforated gastric ulcer had healed, but a penetrating duodenal ulcer was the cause of the persistent symptoms. Both patients were subjected to subtotal gastrectomy and made

TABLE II.

*Follow-up Notes in 13 Cases of Perforated Gastro-duodenal Ulcers with Recurrent Symptoms.*

Case	Year	Name	Location of ulcer. Operation	Subsequent course
1	1916	M.W.	Duodenal. Suture	1927: Epigastric distress. Sour eructations. X-ray examination shows recurrent ulcer.
2	1916	F.R.	Duodenal. Suture	1927: Sour eructations, pains. X-ray examination shows irregular bulb.
3	1917	J.T.	Duodenal. Suture. Gastro-enterostomy	1927: Pains, belching, blood in stool. X-ray examination shows: gastro-enterostomy normal; nothing going through pylorus. Diagnosis: recurrent ulcer.
4	1919	S.K.	Duodenal. Suture	1920: Re-perforation, walled off by liver. Suture of perforation, gastro-enterostomy. 1921: May: Gastro-jejunal ulcer. Disconnection of stoma. Ulcer excised. Jejunum closed. New gastro-enterostomy. 1921: December: Large recurrent gastro-jejunal ulcer. Jejunostomy. 1927: Patient still suffering. Does not want another operation (subtotal gastrectomy.)
5	1920	C.E.	Pyloric. Suture. Gastro-enterostomy	1921: Gastro-jejunal ulcer. Excision of ulcer. Disconnection of stoma. 1924: Partial gastrectomy for ulcer in posterior wall of duodenum with perforation into pancreas. 1927: Patient has clinical and radiographic evidences of recurrent gastro-jejunal ulcer.
6	1920	L.S.	Pyloric. Suture	1927: Patient felt well until 1922. Recurrent attacks once or twice a year. X-ray examination shows a niche and a constriction in the duodenum.
7	1922	A.R.	Pyloric. Suture	1927: Patient has a 27-year-old history of ulcer. Symptoms still persisting. X-ray examination shows an irregular bulb and 1/5 residue after 6 hours.
8	1923	M.D.	Pyloric. Suture	1927: 3 marked recurrences since operation, 2 in 1924, 1 in 1926. Patient is just recovering from 4th recurrence. X-ray examination shows a marked deformity of the duodenal bulb and hypermotility of the stomach.
9	1923	A.D.	Duodenal. Suture	1927: Sour eructations, pain, occasional vomiting. X-ray examination shows irregular bulb.
10	1923	M.L.	Duodenal. Suture	1927: Patient has typical symptoms of recurrent duodenal ulcer. Refused X-ray examination.
11	1924	E.F.	Duodenal. Suture	1925: Subtotal gastrectomy for recurrent duodenal ulcers. Findings: one ulcer at site of old perforation, another ulcer on posterior wall of duodenum, adherent to pancreas. 1927: Perfectly well.



# PERFORATED GASTRO-DUODENAL ULCERS

TABLE II.—Continued

*Follow-up Notes in 13 Cases of Perforated Gastro-duodenal Ulcers with Recurrent Symptoms.*

Case	Year	Name	Location of ulcer. Operation	Subsequent course
12	1924	J.H.	Pyloric. Suture	1927: Patient felt well for 3 months. Since then symptoms have recurred. Marked hunger pain. Patient uses tube every day and drains about one quart from stomach. X-ray examination shows marked retention.
13	1925	P.K.	Gastric at re-entrant angle. Suture	1926: Subtotal gastrectomy for recurrent duodenal ulcer. Findings: scar of previously closed gastric ulcer. Ulcer at posterior wall of duodenum, perforated into pancreas. 1927: Perfectly well.

an uneventful recovery. They are perfectly well and free from any gastric symptoms.

I have recently re-operated a patient, who had been operated on this service for an acute perforation in 1926. This case is reported on page 955. He was not included in this statistical survey. Since we define late results as those occurring after at least two years, we carried our re-examinations up to 1925. Re-operation of this patient revealed an active ulcer, perforated into the head of the pancreas.

A number of patients were subjected to a partial or subtotal gastrectomy on this service since 1922 for recurrent symptoms in whom the primary operation had been performed in other hospitals. They are not included in this review.

It seems to me that this investigation brings out two important points:

(1) A closure of an acute perforation of a gastro-duodenal ulcer (with or without gastro-enterostomy) failed to cure the patient in 39 per cent. of the cases.

(2) In those cases which were subjected to a subsequent partial or subtotal gastrectomy we found another ulcer on the posterior wall of the duodenum which I believe had been overlooked at the time of the primary operation. We have learned from our experiences in resection of the stomach that multiple ulcers occur in about 50 per cent. of the cases. It is therefore apparent that a simple suture of an acute perforation at the pylorus or in the duodenum may fail to relieve the patients of their symptoms in a large number of cases.

The conclusion must necessarily be drawn from this report, that our conservative measures heretofore applied in acute perforations of gastro-duodenal ulcers fail to effect a permanent cure in a very large percentage of the cases. In view of these results the question arises whether it might not be advisable to treat these acute perforations by a more radical procedure. For many years we used conservative methods for chronic gastro-duodenal ulcers and adopted the more radical procedure of subtotal gastrectomy only after we had been convinced that gastro-enterostomy with or without excision of the ulcer

left many patients in a much worse condition than they had been before the operation.

Kreuter, Schwarz, Bruett, Paul and others have published fairly large series of cases showing that, even in the presence of a peritonitis, subtotal gastrectomy does not increase the mortality, if the patient is operated not later than 6 to 12 hours after the perforation has occurred.

We are not prepared at present to adopt this procedure in the presence of an extensive infection of the peritoneal cavity. After all, partial or subtotal gastrectomy is an operation of considerable magnitude. In spite of favorable statistics advocating this procedure we feel at the present time that the mortality might be increased materially, if partial or subtotal gastrectomy would be adopted as a routine procedure in acute perforations of gastro-duodenal ulcers.

However, it may be advisable to attempt a radical cure in cases which come to operation very early and where the infection has not spread beyond the immediate neighborhood of the ulcer.

Furthermore every patient who has been subjected to the conservative procedure should be watched carefully in the follow-up clinic. If the patient still has marked symptoms six to eight months following the operation he should be subjected to a partial or subtotal gastrectomy.

Thanks are due Doctors Beer, Berg, Elsberg, Lilienthal and Moschowitz for their kind permission to study patients operated by members of the surgical staff on their services.

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# ASEPTIC END-TO-END INTESTINAL ANASTOMOSIS

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THERE are many reasons why an end-to-end anastomosis of intestine is more desirable than a lateral anastomosis: (1) It reestablishes the intestinal continuity in its normal anatomical relationship, (2) it does not in the least interfere with the physiology of the restored parts, and (3) the operation is less time-consuming than the lateral anastomosis and can be carried out in a well-nigh aseptic manner.

That there are yet no standard procedures for this very important operation is shown by the large number of proposed methods which have been published in recent surgical literature. A casual review of the subject covering the past five years reveals no less than thirty different methods. Some are obviously too complicated for common practice, while others, calling for manipulations which invite contamination, cannot be considered as "aseptic anastomosis." There are, however, a group of proposed methods which are worthy of comment because of their ingenious nature; these have in common the four following basic principles:

1. The aseptic excision of a segment of intestine.
2. The temporary closure of the ends of the intestine.
3. The abutting and anastomosis of the two stumps by appropriate sutures.
4. The opening of the double diaphragm.

The excision of a segment of intestine is generally done by cautery; where cautery is not available, it is done by knife, followed by the application of pure carbolic acid and alcohol. That the abutting blind ends are best sewed together by properly placed silk mattress sutures is the consensus of opinion of the various authors. The second and fourth principles are intimately related to each other, and it is in their execution that surgeons vary their technic.

Halsted, one of the pioneers in the development of intestinal anastomosis, early practiced the tying-off of the ends of intestine with catgut which was relied upon to melt away promptly. Later, limiting his experiments to the colon, he had the double diaphragm cut by means of a knife inserted by rectum.

Highsmith looped the ends of intestine by linen or catgut ligatures which were held taut by means of specially devised loop-clamps. After completion of the anastomosis, the loops were cut in one leg and then pulled out. Burns employed a ball over which the blind ends of the intestine were sutured. The removal of the ball through the intestinal lumen necessarily broke the purse-string sutures which tightened the ends. Collins suggested placing clamps over retention loop ligatures which had first been held taut. After completion of the anastomosis, the clamps were removed and the loop ligatures pulled out.

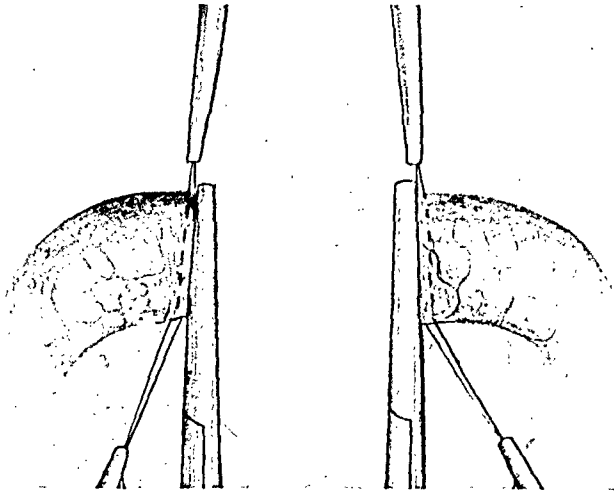


FIG. 1.—A segment of intestine has been excised. The purse-string sutures have been placed. The two Halsted clamps at the intimesenteric borders are holding together the cut ends of the purse-strings.

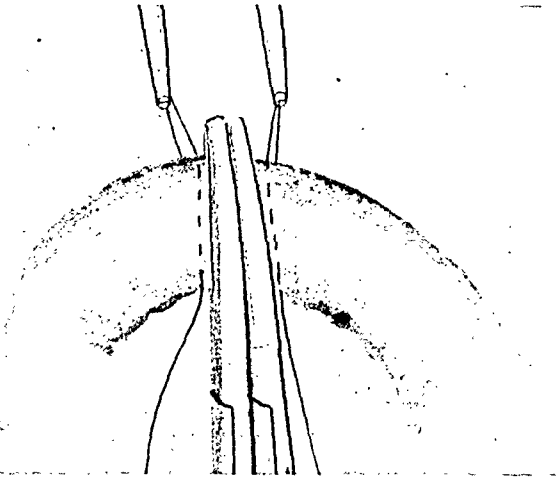


FIG. 2.—Same as Fig. 1 with ends of intestine abutting.

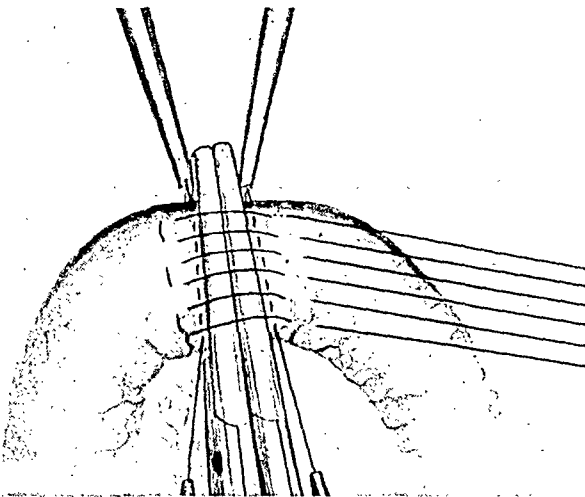


FIG. 3.—Placing of mattress sutures on one side.

Horine had a very ingenious method of loosening a purse-string suture. He placed a free hand string of linen thread between the gut and the first knot of the purse-string suture, and another between the first and second knots. With the pulling of the two releasing strings, the knots of the purse-string sutures were loosened.

Fraser and Dott of Edinburgh and Webster of Peking then developed independently what the writer thinks is the best and safest method for aseptic end-to-end anastomosis of intestine. Both methods called for a specially devised knife which was threaded onto the purse-string ligature, and which cut it upon completion of the anastomosis. The specially devised knife, Fraser and Dott named "the ligature guillotine" and Webster "the revolving tubular knife."

The latest significant contribution to the methods of aseptic end-to-end anastomosis was made by Scarff of Baltimore. He closed the ends of intestine by crushing them, no purse-string being employed. Scarff's method is undoubtedly the easiest and simplest,

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if the ends can be relied upon not to open at a critical moment.

The writer does not claim entire originality for his technic, which is largely based upon the methods of Webster, Fraser and Dott. It differs from theirs, however, in the important respect that no specially devised instruments are needed. Thus the operation can be carried out in any small hospital and at any time when there is need of such a drastic measure as partial excision of the intestine.

*Technic.*—The abdomen is opened in the usual manner and the desired segment of intestine delivered outside the wound. The two points of section having been decided upon, the mesentery is detached to about one centimetre beyond these points. Hæmostasis is carefully secured by ties or transfixing sutures. Two straight Kocher clamps are then applied to each end of the segment to be excised. Excision is done by electric cautery between clamps. The clamps holding the ends of intestine are further "cooked" by the cautery for 15–20 seconds. Beginning from the mesenteric border of one

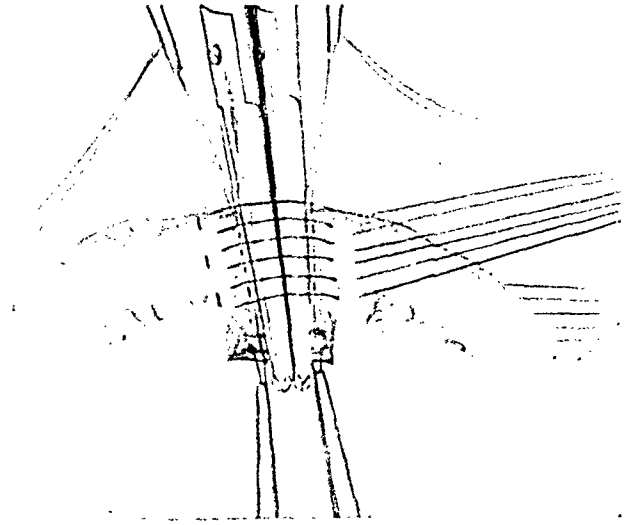


FIG. 4.—The intestine has been turned. The placing of mattress sutures on the opposite side has been completed.

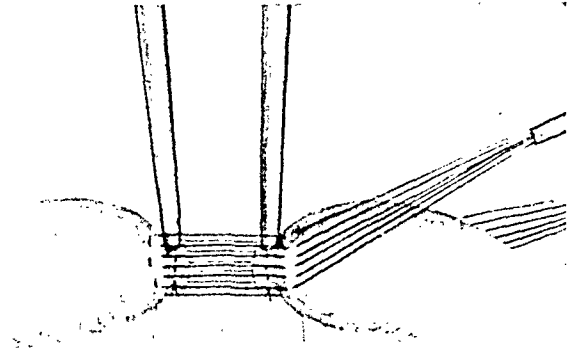


FIG. 5.—Kocher clamps removed and the purse-string sutures tightened. The ends are now blind. The Halsted clamps are still holding the cut ends of the purse-strings.

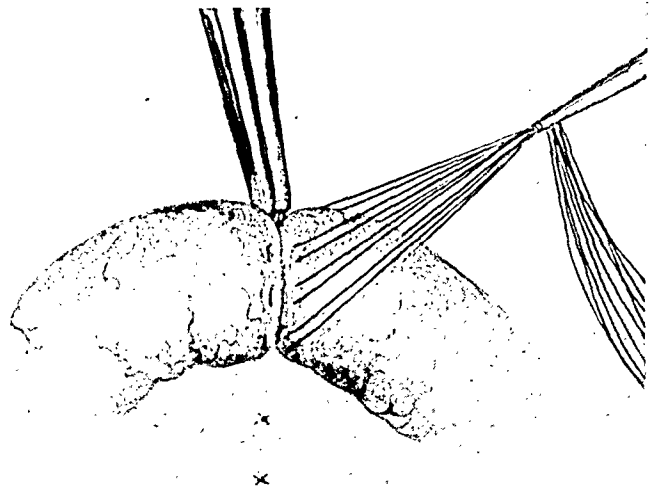


FIG. 6.—All mattress sutures tied. The blind ends are in perfect apposition except at the point where the two Halsted clamps protrude.

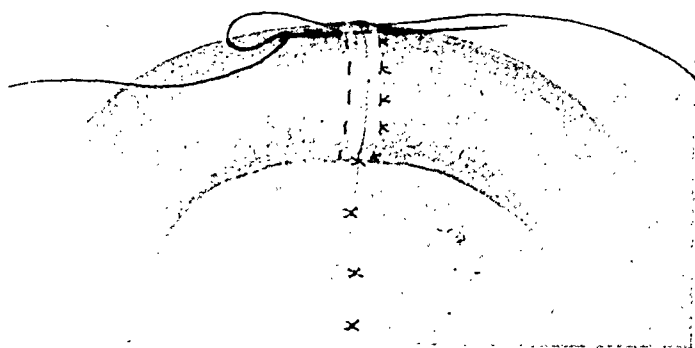


FIG. 7.—Halsted clamps removed. Reënforcement sutures are being applied.



FIG. 8.—Specimens removed from experimental dogs. A, Right after completion of anastomosis. B, One week after operation. C, Two weeks. D, Three weeks. E, Four weeks. F, Five weeks. G, Six weeks.



FIG. 9.—Microphotograph of section 1-10 showing the diaphragm. Immediately after anastomosis.

end, a median silk purse-string suture is placed close to the clamp. The suture is intended to catch the submucous layer, but without entering the lumen of the intestine. The segment of the purse-string suture as it appears at the anti-mesenteric border is then picked up and cut. The cut ends are immediately clamped together by an ordinary straight hæmostat (Halsted) so that the purse-string effect is still intact. The other end is similarly treated. (See Fig. 1.)

The two Kocher clamps are then brought into apposition (Fig. 2) and a row of medium silk mattress sutures are properly placed, first on one side and then on the other. These sutures are also placed through the submucous layers, and as close to the purse-string as possible. Care must be exercised not to catch the purse-string in the placing of mattress sutures. (Figs. 3 and 4.) As the assistant releases the Kocher clamp, the operator steadily tightens the purse-string and ties a double knot at the mesenteric border. The knots are cut short. (Fig. 5.)

The two blind stumps are then held in intimate

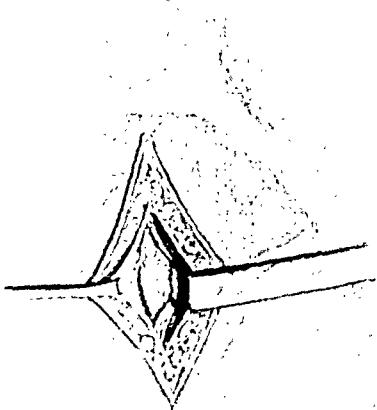
The resulting defect is not a hernia but a bulging due to paralysis which cannot be cured by surgery.

The incisions commonly used in the upper abdomen and in the pelvis are through the right or left rectus muscle or through the linea alba. As has been previously stated, an incision which splits the recti muscles produces a permanent defect. Midline incisions are defective also in that they give but one facial plane to suture which is insecure and also leads to a diastasis recti. In the clinic of Doctor Ashurst we use routinely in the upper abdomen and in the pelvis the right or left paramedian incision (Figs. 2 and 3). After opening the anterior sheath of the rectus the muscle is dissected free along its inner border and retracted outwardly. The posterior sheath and peritoneum are opened beneath. The nerve and blood supply are thus preserved. The aponeurotic layers having been cut in different sagittal planes, the secure closure can be obtained. In operations upon the gall-bladder, instead of using the right rectus, the pararectus, or the Mayo-Robson incision, all of which leave permanent defects, we use a right paramedian oblique incision (Fig. 4). It begins across the midline just below the ensiform extending downward and outward across the right rectus to a point beyond the linea semilunaris at a level of the umbilicus.

The anterior sheath of the rectus is opened in the direction of the skin incision, the muscle is dissected free along its inner border, and lifted outwardly, and the posterior sheath and peritoneum opened beneath in a line parallel to the linea alba. This incision gives ample exposure to the fundus of the gall-bladder and an excellent exposure to the bile-ducts which is of much greater importance. Here again the fasciae are severed in different sagittal planes.

In operations on the appendix there are several incisions commonly used all of which are open to criticism. The gridiron or muscle-splitting incision of McBurney gives a poor exposure and often has to be enlarged. In so doing it ceases to be a muscle-splitting and becomes a muscle-cutting incision. The pararectus or the incision through the linea semilunaris gives a good exposure, but unless very short it necessarily severs one or more of the thoracic nerves. The same may be said of the incision through the right

Fig. 3.—Right paramedian hypogastric incision, rectus muscle retracted outwardly.



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apposition by the hands of an assistant; while those of another assistant steady the Halsted hæmostats which are holding together the tight purse-strings. The mattress sutures are then held taut and tied one by one. The segments are now in perfect apposition except at the anti-mesenteric border where the two Halsted clamps protrude. (Fig. 6.)

These clamps are subsequently removed and a mattress suture immediately placed to cover over the defect. The removal of the two Halsted clamps releases the two purse-string sutures of the blind ends. Gentle pulling of the traction sutures in a four-quadrant direction, but mainly in the two lateral directions, will readily bring open the intestinal lumen at the junction of anastomosis. A few reinforcement sutures in the form of Lembert or mattress sutures here and there now complete the anastomosis. The divided mesentery is sutured by interrupted fine silk sutures. (Fig. 7.)

Aseptic end-to-end anastomosis according to the writer's technic has been done a dozen times on dogs. None of the dogs died as result of the oper-

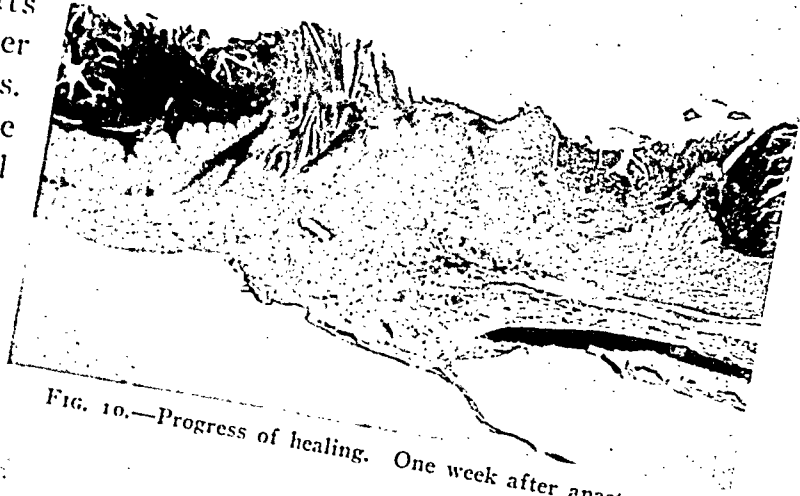


FIG. 10.—Progress of healing. One week after anastomosis.

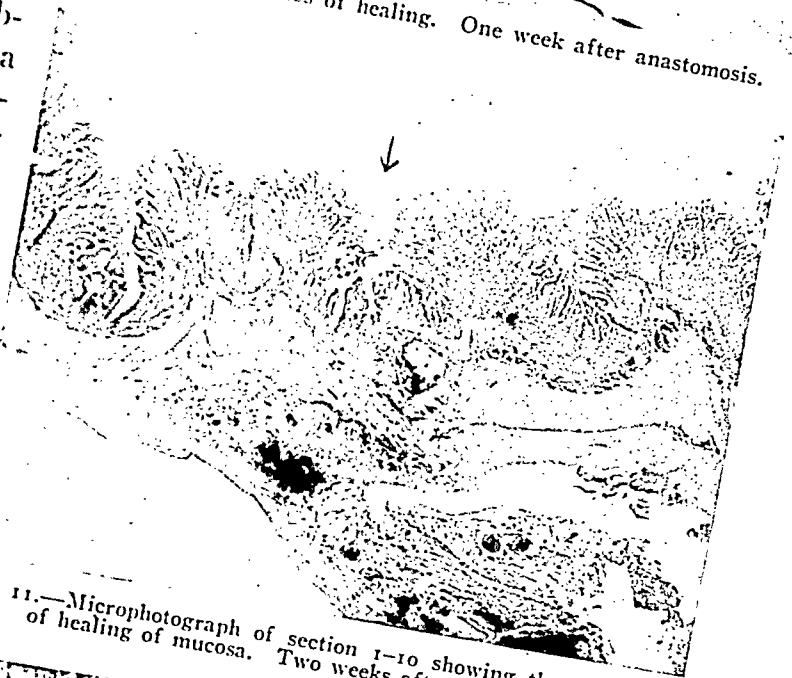


FIG. 11.—Microphotograph of section 1-10 showing the beginning of healing of mucosa. Two weeks after anastomosis.



FIG. 12.—Microphotograph of section 1-10 showing more advanced stage of healing of mucosa. Three weeks after anastomosis.



ation, and all had uneventful post-operative histories. At periods varying from a week to six weeks, these dogs were again operated for excision of the specimens. No peritonitis was found and only slight adhesion in two dogs at the site of anastomosis. All specimens are patent. The double diaphragms had sloughed off, even in the one-week specimen. The silk purse-string sutures are seen in the one-week and two-week specimens working their way out into the intestinal lumen. After three weeks, the healing process was found to be complete. (Fig. 8.)

*Summary.*—A simple method of aseptic end-to-end anastomosis of intestine requiring no special instruments is presented.

This method has been used successfully twelve times on dogs.

N.B. My thanks are due to Mrs. E. B. A. Macmillan who gave valuable suggestions in the preparation of this paper and to Mr. Pu Chang-hai who made the drawings.

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# ACUTE INFLAMMATORY OBSTRUCTION OF THE TERMINAL ILEUM

By CLYDE A. ROEDER, M.D.  
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IN THE *Boston Medical and Surgical Journal* for May, 1913, David Cheever described the acute inflammatory obstructions of the terminal ileum which sometimes follow an operation for acute suppurative appendicitis with rubber or gauze drainage. I think he was the first to describe this condition, since I have been unable to find any other description prior to his publication. Most surprising to me is the almost total lack of recognition of his article and the condition he described. Just previous to his publication, I had experienced several similar examples, but was then unaware of the exact pathological anatomy. Fortunately, however, I had recognized the pathological physiology and reported three cases, with recoveries, in the *Boston Medical and Surgical Journal* for August, 1913. Cheever's method of relief was the performance of an ileostomy through the incision previously made for the acutely inflamed appendix. Owing to uncontrollable circumstances, *i.e.*, poor surgical environment and a more limited experience at that time, I, fortunately, was forced to adopt an easier surgical procedure, *i.e.*, an ileo-sigmoidostomy—which I have followed ever since.

During the past fifteen years there has gradually, but too slowly, crept into the minds of the profession the idea that the ileus due to intraperitoneal infections, is as potent an agent in the production of fatalities as the primary peritoneal sepsis. During this time, intestinal drainage operations, including the popular jejunostomy, have been presented and practiced with no small degree of success. It is well to keep in mind that an inflammatory obstruction of the small intestine, rarely the colon, frequently occurs in the presence of septic intraperitoneal exudates and often more rapidly dominates the clinical picture and more rapidly hastens the mortality. It is also well to keep in mind that distention, particularly in the left lower portion of the abdomen, with vomiting and signs of dehydration, coming on forty-eight to seventy-two hours following an operation for purulent appendicitis with peritonitis indicates, in most instances, an acute obstruction of the small intestine. I feel confident in stating that the failure to recognize this complication and to apply early, proper surgical relief, is one of the main reasons for our high mortality rate following operations for acute suppurative appendicitis complicated with purulent peritonitis.

Since 1910, I have operated upon twenty-one patients with inflammatory obstructions of the terminal ileum due to purulent appendicitis and peritonitis and have had only one mortality. This record prompts me to make this report, owing to the high mortality rate still persisting following opera-

tions for the purulent appendix and the even higher mortality rate following all operations for intestinal obstruction. Twenty out of this series were due to the purulent appendix and one to an infected right Fallopian tube. The one fatality was quite likely due to the fact that I applied surgical relief too late. In this series, the youngest patient was an infant two years old and the oldest, a man in the seventies. The histories in all were, singularly, quite similar, excepting in the one case with the acute salpingitis which had not been

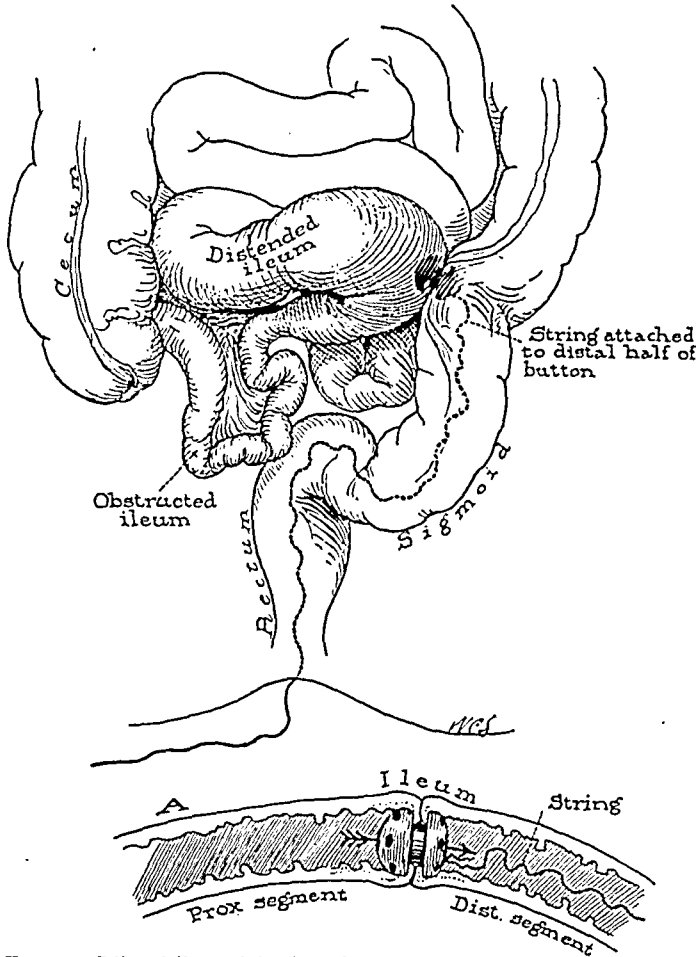


FIG. 1.—Dilated ileum joined to the sigmoid with a Murphy button. Note the string attached to the distal portion of the button.

the leucocyte count never proved of any value. In my experience leucocytosis generally accompanies an acute intestinal obstruction in its early stages. It is needless to state that satisfactory evacuation of the bowels per rectum was absent, particularly the failure to pass gas. The clinical picture is generally easily recognized after the first experience. When once recognized, the application of immediate surgical therapy should not be delayed, since the patient has two highly fatal lesions—peritonitis and intestinal obstruction, the latter always fatal if not relieved.

In the first case of my series of twenty-one, I made an exploratory incision through the left rectus in a field well away from the area of previous operation. In every case following I used the same procedure and was very

operated upon previously to the operation for the relief of the acute obstruction of the small intestine. In the twenty cases of acute post-operative obstruction of the terminal ileum due to appendiceal and peritoneal sepsis, the left side of the abdomen first showed distention, with cramp-like pains, starting forty-eight, seventy-two, and up to 144 hours following the operation. As the distention increased, more frequent vomiting and signs of dehydration followed. The relatively low temperature and the lack of rigidity on the left side all pointed against an advancing peritonitis. The pulse rate increased rapidly, but the already elevated temperature did not correlate and

## ACUTE INFLAMMATORY OBSTRUCTION OF TERMINAL ILEUM

much impressed, in most instances, with the almost total absence of purulent fluid in the left side of the abdomen. The terminal ileum was always found greatly dilated down to an area in the right pelvis where a plastic exudate was found sharply kinking and constricting the terminal portion. The most distal portion of the dilated ileum was joined to the sigmoid in each instance and in only two cases, as far as I have been able to determine, did this anastomosis leave the function of the ileo-colonic tract disturbed. In the infant of two years, with acute purulent appendicitis, a troublesome diarrhoea in spells kept up for at least one year after the operation. I was unable to trace this patient after that. In the female with acute salpingitis, an arthritis developed about one year after the operation, which may or may not have been due to ileal absorption of colonic contents.

The main objection to this operation is the possibility of a circling of ileal contents through the colon after the patient has completely recovered; such as occurs sometimes following the ileo-sigmoidostomy of Arbuthnot Lane for colonic stasis. One might well bring up the point that a jejunostomy is more satisfactory, and I have no inclination to dispute the relative merits of this procedure as compared with a direct ileostomy.

In two instances I used a suture technic for the anastomosis, both cases being recognized early and the time element, under local anæsthesia, was not quite so important as in the remaining nineteen cases. In the first three patients operated upon, a Murphy button was used and was passed via the rectum in a few days. In the fourth case the button passed onward into the distal ileum, becoming obstructed at the point where the small intestine was constricted by the inflammatory exudate. It was necessary for me to remove this button two months later through a mid-abdominal incision. In the sixth case the button became lodged in the terminal ileum as in the fourth, but about six weeks later worked its way through the obstructed area in the ileum, finally being passed by rectum. With this experience in the fourth and sixth cases, I decided to attach a heavy silk or linen cord to the distal half of the button in order to obtain, if possible, traction sufficient to compel the movement of the button in the desired direction. Since adopting this method, each button has, in varying lengths of time, passed into the sigmoid. In about half of the instances the cord protruded through the anal canal where additional traction was easily applied. I have used the button with a string attached in an adult following a resection of the small intestine with satisfactory results.

I again wish to state that I feel that suture anastomoses are more desirable than the use of mechanical appliances; but when the patient is desperately ill with an acute obstruction of the small intestine following almost immediately upon an operation for purulent appendicitis and peritonitis, the most rapid method is desirable. With the button one can easily finish this operation in five to ten minutes, and with this modification, its use, with an emergency ileo-sigmoidostomy, leaves very little more to be desired relative to the immediate results.

## FIBROMATA OF THE MESENTERY

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THE early history of solid tumors of the mesentery is well recorded by Harris and Herzog,<sup>6</sup> who collected fifty-six cases from the literature up to 1897 and reported one of their own. Of the solid tumors of the mesentery fibromyomata seem to be the most rare.

Greer<sup>4</sup> in 1911 reported a case and reviewed the literature for the last ninety years. He was able to find only thirty-two cases of mesenteric fibroids. His article gives instructive details of them all. His own and the thirty-two others were of a fibromatous nature. Cysts of the mesentery, while not common are about four times more common than solid tumors.

Bevan,<sup>2</sup> 1918, removed a large tumor growing from the mesentery in the cæcal region by clamping and cutting its broad pedicle, only to find, to his dismay, that in cutting away the tumor he had opened the cæcum and ileum, both of which were adherent to its under surface. He was compelled to carry out a resection of the damaged bowel. The tumor on examination proved to be a fibroma. Solomons<sup>8</sup> in the same year recorded a case which he described as fibrosarcoma.

Judd and McVay<sup>9</sup> of the Mayo Clinic, 1920, reported a case of fibroma of the mesentery and brought the literature up to that date. There have been few cases recorded since.

Rawls<sup>10</sup> had a case in which there was a cavity in the tumor mass communicating with the small intestine by a fistula which had ulcerated through from the attached surface. The cavity was filled with foul smelling substance made up of food, blood clots, etc. He discounts the question of its origin being a diverticulitis, since the mass lay entirely within the leaves of the mesentery. The cavity was not mucous lined and the section showed fibroid tissue with few blood-vessels.

In the case of McCauley<sup>11</sup> the tumor and attached bowel was resected. The tumor in gross section resembled a uterine fibroid. It was so intimately related to the intestinal wall that it appeared to have its origin in the bowel musculature. Kyle<sup>12</sup> reported a case which was very vascular and suggested sarcoma but proved to be simple fibroma. DeCourcy<sup>13</sup> reported a case and J. F. Baldwin<sup>14</sup> had a very interesting case in a colored woman, which weighed twenty-five pounds and which he claims to be the largest case of this kind on record.

Always in the rare things in medicine there must be a considerable number of cases which occur but which are never reported and it seems a duty, therefore, when one meets in his experience one of the rare cases to record it. The case submitted herewith brings the reported cases up to 41 in number.

CASE REPORT.—T. D., a young married colored woman of twenty-five years, mulatto in type with a practically negative family history and with no clinical history other than some of the infectious diseases of childhood and a few colds, noticed an enlargement of the abdomen. She has had some pain in the epigastrium, a dragging feeling and attacks of nausea and vomiting and she has lost weight. She has had no children or miscarriages, her menses appeared at the age of fourteen and have been regular, without pain and lasting about seven days. She does not suffer from leucorrhœa. Her pelvic organs are normal. There are no tumors, cysts, disease of the Fallopian tubes or ovaries. Her urine is acid specific gravity 1022 and without casts, but there are numerous pus

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cells and some albumen. Her blood shows a negative Wassermann, 4,700,000 reds, 11,800 whites, polymorphonuclears 68 per cent. and hæmoglobin 90 per cent. Her appetite is good, bowels regular and she states that her general health has always been good.

The abdomen was opened in a midline incision. The pelvic organs, stomach and upper abdomen showed nothing abnormal. There was a tumor mass measuring 21 x 18 cm. lying between the leaves of the mesentery, of the ileum about ten cm. from the ileocaecal junction. There were no adhesions, the tumor was movable, but presented on its surface numerous large dark veins. The tumor mass with about thirty inches of ileum was removed. An anastomosis of the ileum was done and the appendix removed. The patient went into shock and died about eight hours after the operation.

Pathological report by Dr. Robert Kilduffe.—Specimen consists of a large mass measuring 21 x 18 cm., of fibrous tough consistency. There is attached to this and hugging it closely, thirty inches of small intestine. On section the mass is dense, firm and has a somewhat fatty appearance. Its shape is roughly globular. It has the general appearance of being encapsulated. A large portion of adherent omentum accompanies the specimen. Microscopically the histology is that of a fibroma in which there are a moderate number of small vessels which are more or less congested. There is no histological evidence of syphilis, tuberculosis, or malignancy.

Quoting from Judd<sup>9</sup>: "The origin of mesenteric tumors offers many interesting hypotheses, but has been very little discussed by any of the writers on the subject. Greer<sup>4</sup> states that fibromas develop in the connective tissue, grow slowly and rarely recur after complete removal. Royster<sup>6</sup> believes that all such tumors are of mesoblastic origin, solid or cystic and that the solid tumors may be either benign or malignant."

The other theory is that these tumors originate in the uterus as fibroids, become migratory in character and attach themselves to the mesentery. Benign migratory tumors rarely affect the essential circulation of the part to which they may become attached. Together with the fact that no other fibroid tumors were found in the uterus and that this tumor was confined between the leaves of the mesentery it is more probable that this tumor grew *in situ*.

The diagnosis of mesenteric tumors is rarely made before the abdomen is opened and is impossible in most cases. The mortality is high. Vance<sup>7</sup> reports a mortality of 46 per cent. where resection of the bowel was done and Begouin's<sup>1</sup> mortality was 52 per cent.

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## LYMPHANGIOMA OF OMENTUM

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LYMPHANGIOMA is a tumor composed of lymph-vessels. It is therefore an organoid structure consisting of endothelial cells and supporting connective tissue, both of which are involved in the neoplastic process. Lymph-nodules or foci of round cells are often present to complete the parallel with a lymphatic structure.

The very early stages and exact origin of these tumors have not been demonstrated, and as Hedinger points out, they require differential diagnosis from a variety of other abdominal cysts. Their neoplastic nature seems assured since the walls contain cellular connective tissue, often much smooth muscle tissue, and lymph-follicles. After partial removal the remaining portion may rapidly increase in bulk. Along the edges of the growths, Sick found proliferating areas of cavernous lymphangioma. He assumes that they arise from misplaced and embryonal islands of connective tissue and lymph-vessels. In the omentum and mesentery of newborn cats and pigs, Ranvier has demonstrated such misplaced islands of tissue.

In the origin of lymphangioma it must be assumed that there exists a local predisposition resulting from an embryogenic disturbance similar to that assumed for hæmangioma. Of the nature of this disturbance nothing is definitely known, but the congenital origin of most lymphangiomata is a striking feature in their etiology. A partial isolation of a segment of lymph-vessels with imperfect development and retention of abnormal powers of growth may be supposed to exist. New formed lymph-vessels are also present in many benign and malignant tumors, especially with endothelioma and sarcoma.<sup>1</sup>

Adami in considering cavernous lymphangioma states that he finds extensive overgrowth, with fibrosis of the parts between the dilated lymph spaces. The conditions are all congenital, and we must conclude that there is obstruction to onward flow of the contained fluid, due to some abnormal relationship of the different vessels.

These cysts are lined with endothelium, containing clear lymph, and having fibroid walls. Many of the large cysts appear to be absolutely closed off, not communicating with their neighbors. We must suppose that, with increasing distention, there has been a valve-like closing of the channel of which they are a dilatation, that the endothelium has grown *pari passu* with the dilatation, and that this endothelium has secretory powers. The mere force of the lymph flow cannot explain such extreme development; we have to assume active excretion, which, indeed, is indicated by many other considerations

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and actual experiments of Heidenhain.<sup>2</sup> He further differentiates telangiectatic cases, such as cervical hydrocele, sacral hygroma, growth of lymph channels *pari passu* with other changes in tumors or malignancy, from true lymphangiomas.

Some fifty cases of omental cysts are reported in the surgical literature. About 50 per cent. are in adult life. Of these, the majority are in the female; many of these are of the secondary variety, subordinate to tumor formation and cannot be considered as true primary lymphangiomas. The other 50 per cent. of reported cases are under ten years of age and are considered embryonic.

But few, if any, subjective symptoms are present, except those due to inflammation or torsion of cysts with resultant hemorrhage and inflammation. Pean describes three points in diagnosis: superficial location, abdominal passive mobility with downward movement limited, and absence of functional disturbance.<sup>3</sup> Hearn and Arzela diagnosed omental cyst by exclusion; Stillman an omental cyst or ovarian cyst with long pedicle.<sup>4, 5, 6, 7</sup> In differential diagnosis, tuberculous peritonitis, ascites, and ovarian cysts must be considered.

Hasbrouck claims a 6 per cent. mortality.<sup>8</sup> Extirpation of primary lymphangiomas is the only method of cure. Tapping of cysts, secondary to tumor formation, has been reported successful after excision of tumors. Removal of malignant growths with complete omentectomy for transplantation omental cysts, and followed by intensive X-ray, has not prevented recurrence and ultimate death of three cases in the writer's experience.

CASE REPORT.—Edwin D., age four, was admitted to St. Vincent's Hospital suffering from acute abdominal pain. Family history is negative. Personal history is negative, except infected tonsils. Pale, well nourished, a pendulous abdomen had been noted lately and ascribed to an appetite above the normal. Three days before admission he complained of abdominal pain and distress, increasing in severity and paroxysmal in type. Examination revealed a large abdomen with numerous dilated veins, a hard mass in the upper left quadrant, pain felt on pressure and reflected to left inguinal region and causing marked flexure of both thighs. The

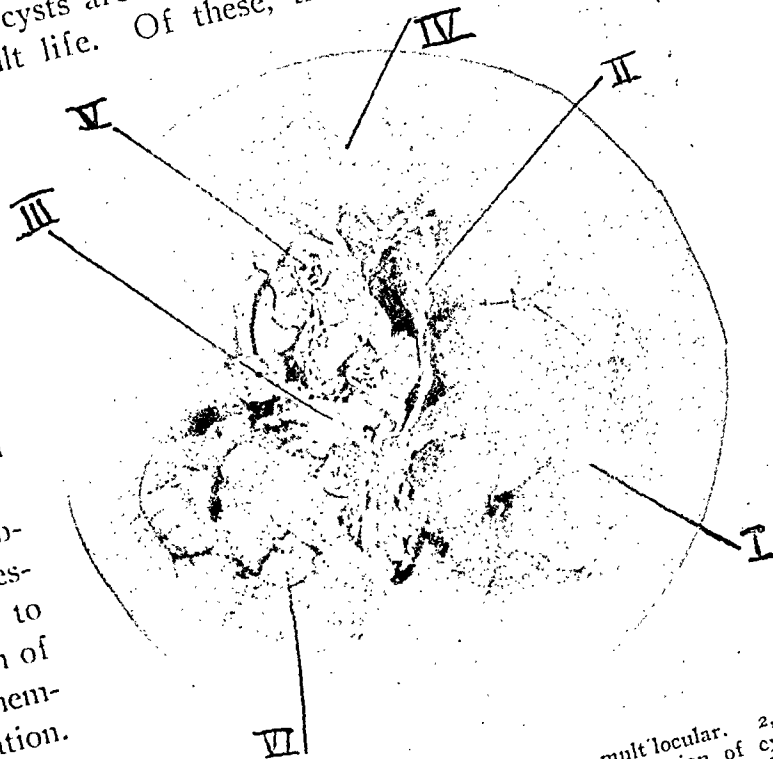


FIG. 1.—1. Large thin walled cyst—multilocular. 2, 3. Hyperplastic lymphoid tissue. 4. Thickened portion of cystic wall. 5. Inflamed and contracted omental remnant. 6. Multi-locular cyst with firm fibrous wall.



rest of abdominal cavity filled with a large, flaccid, fluctuating cyst. Pulse and temperature ranged around 100. Examination of blood shows Kahn and Wassermann and repeated tests for filaria Bancrofti were negative. Red 4,296,000; white 13,050; polymorphonuclears 75 per cent.; lymphocytes 21 per cent.; mononuclears 2 per cent.; transitional 1 per cent.; eosinophils 2 per cent.; slight microcytosis noted. Examination urine practically normal, except 2+ acetone. White blood-cells and mucus. Chyluria as well as chylorrhœa negative.



FIG. 2.—Wall of large lymphatic cyst of omentum, lined by flattened endothelium, beneath which there is a zone of inflammatory fibroblastic tissue. Beneath this, in the omentum, are dilated lymph vessels. (Cystic lymphangioma.)

*Operation.*—Under ether anæsthesia February 17, 1927, upper right rectus incision disclosed a large multilocular cyst, filling the abdominal cavity and attached to the hilus of the spleen, one-half of gastro-colic omentum and splenic flexure of colon. At this point rotation of one large and several smaller cysts had produced circulatory obstruction with resultant inflammation and hemorrhage in cyst cavities. The normal gastro-splenic omentum and one-half of the gastro-colic were replaced by a thickened dark, grayish, fibrous tissue. This tissue extended from over the right of the median line to the left in its entirety. One large cyst filled the entire upper and lower right quadrant, the second largest the lower left, the third cyst with numerous smaller ones, radiating along the course of the blood-vessels had rotated at the splenic flexure of the colon and filled the upper left quadrant. This entire mass with its fluid contents weighed twelve pounds.

The operation consisted in the complete extirpation of the cyst bearing omentum, dividing it longitudinally beyond the line of fibrosis of gastro-colic omentum, and dissecting closely from the under surface of colon in its entirety to the left. (Fig. 1.) The incision was closed without drainage. Convalescence was uneventful and patient discharged March 9, 1927. At present writing no evidence of recurrence and patient in perfect health.

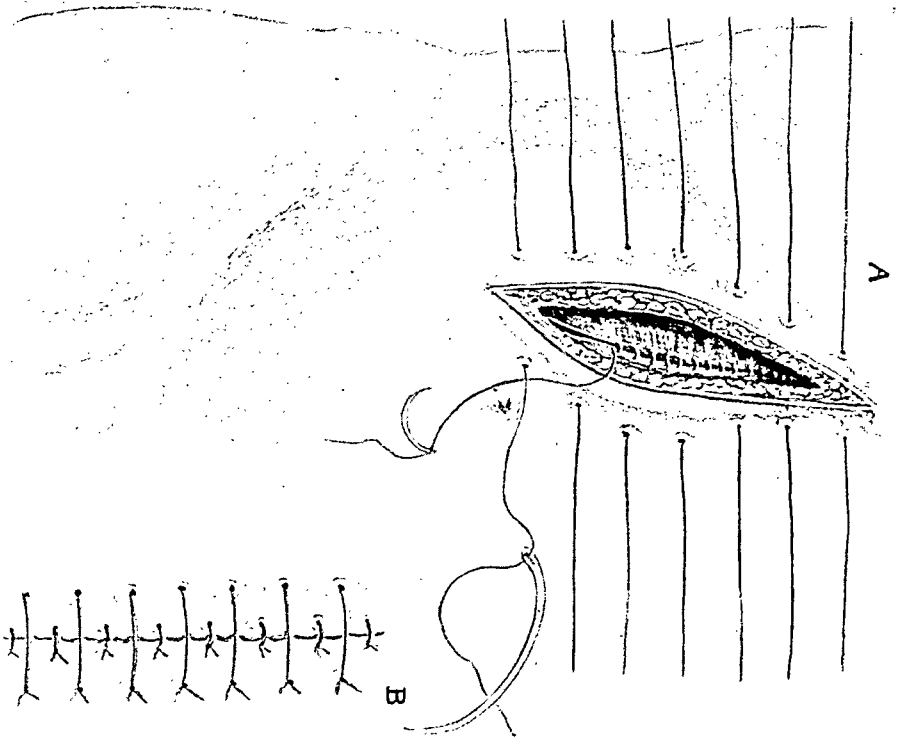


FIG. 4.—A. Right paramedian epigastric incision, oblique. Used for surgery of gall-bladder and bile-ducts. Splint sutures in place. Aponeurosis sutured. B. Splint sutures tied.

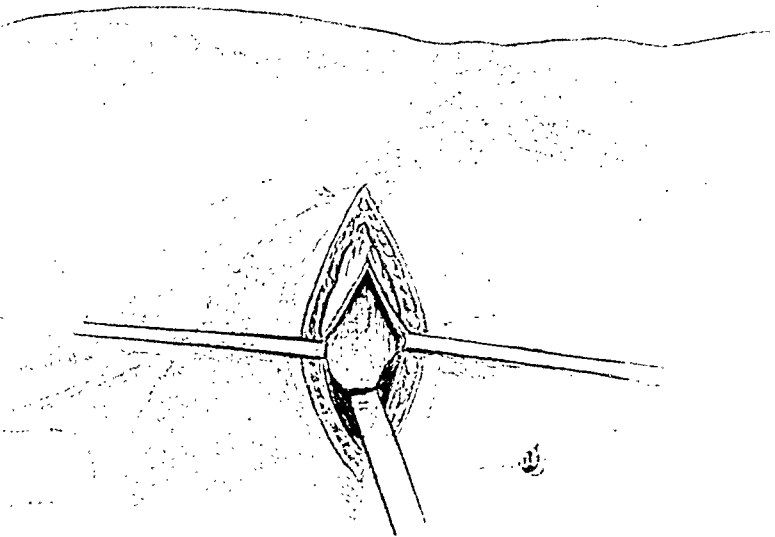


FIG. 5.—Transverse incision of G. G. Davis. Anterior sheath of rectus and aponeurosis of external oblique split. Rectus retracted outwardly.

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*Pathological Report* by Dr. Thomas L. Ramsey. Tissue taken from the cyst wall shows a cyst lined with flattened endothelium. Beneath the endothelium there is a narrow zone of inflammatory fibroblastic tissue continuous with the tissue of the omentum. Throughout the adipose tissue of the latter are numerous irregular sinusoidal or cavernous dilated lymphatic vessels, lined with flattened endothelium and containing lymph. Throughout the adipose tissue, and especially around the cystic lymphatics there is a diffuse inflammatory infiltration and fibroblastic proliferation of slight degree. In the wall of

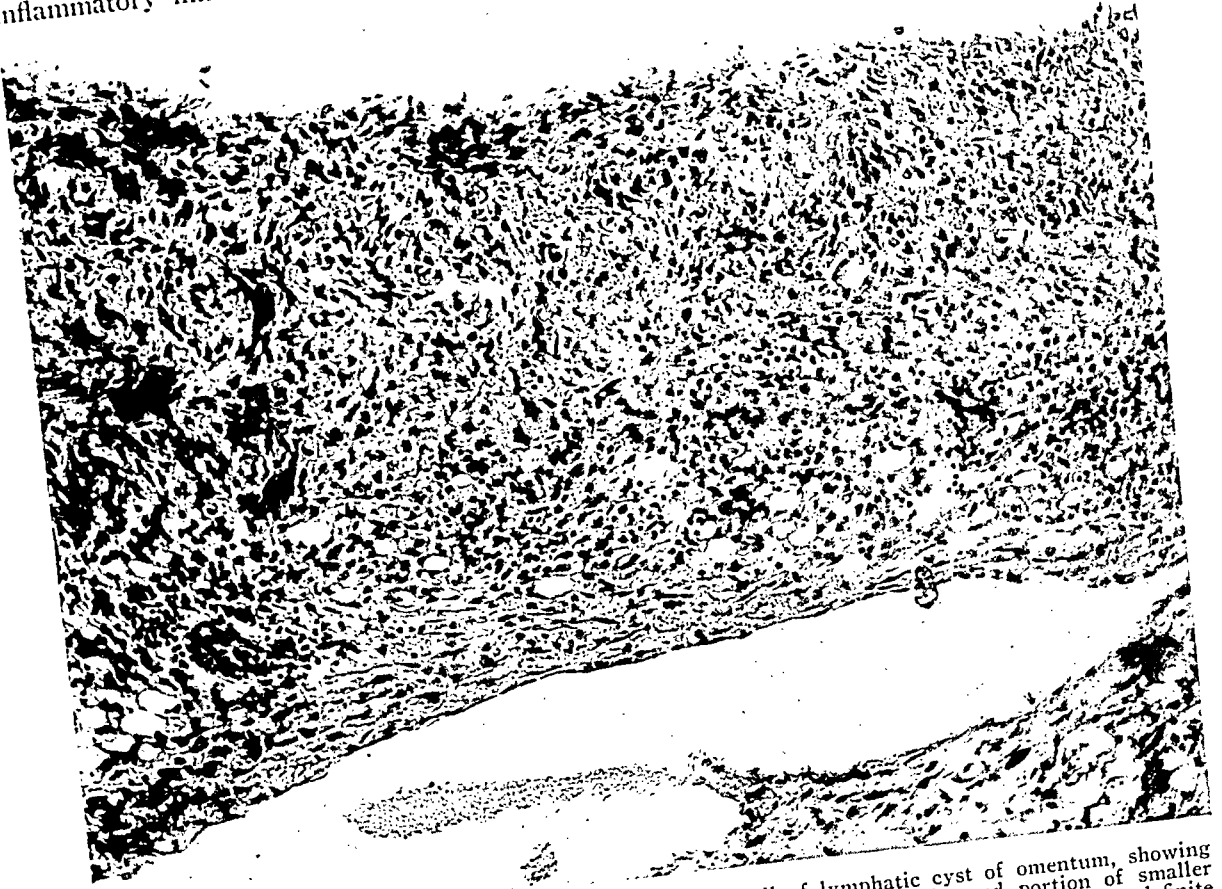


FIG. 3.—Higher power photomicrograph of portion of wall of lymphatic cyst of omentum, showing flattened endothelium lining wall of large cyst, fibroblastic zone beneath this, and portion of smaller lymphatic cyst below. Unstriated muscle cells in cyst wall; in some places these appear in definite bundles.

the larger dilated lymph-vessels small bundles of unstriated muscle are present; and occasionally a small group of lymphoid cells. (Figs. 2, 3, 4, 5.) **Pathological Diagnosis.**—Cystic lymphangioma (chylous cyst); congenital, lymph stasis. Not a true neoplasm, but a congenital disturbance of development. Inflammatory changes secondary due to pressure. No malignancy.

Dowd analyzed thirty-seven collected cases in 1917. Of these five, and possibly another, microscopic findings show endothelium of cyst wall; two had epithelium; fifteen had fibrous tissue; eighteen dark-colored fluid.<sup>9</sup>

Rodman reported cyst of sixty pounds; Ormsby one of seventy-five pounds filled with fluid too thick to flow; Karas one associated with pyæmia with ciliated cells lining cyst wall.<sup>10, 11, 12</sup>

Omental cysts associated with uterine myomæ reported by Outerbridge and Girvin. Both characterized by fibrous wall and endothelium. In both inflammation and adhesions produced lymph stasis.<sup>13, 14</sup>

Funk reports cyst containing three gallons of fluid, fibrous tissue and endothelium.<sup>15</sup>

Pybus, case age four, football in size; no epithelial layer, and peeled from omentum.<sup>16</sup>

Arzela, case three years old, cyst contained one and one-half litres of transparent fluid, and believes the cause is an anomaly of development of a

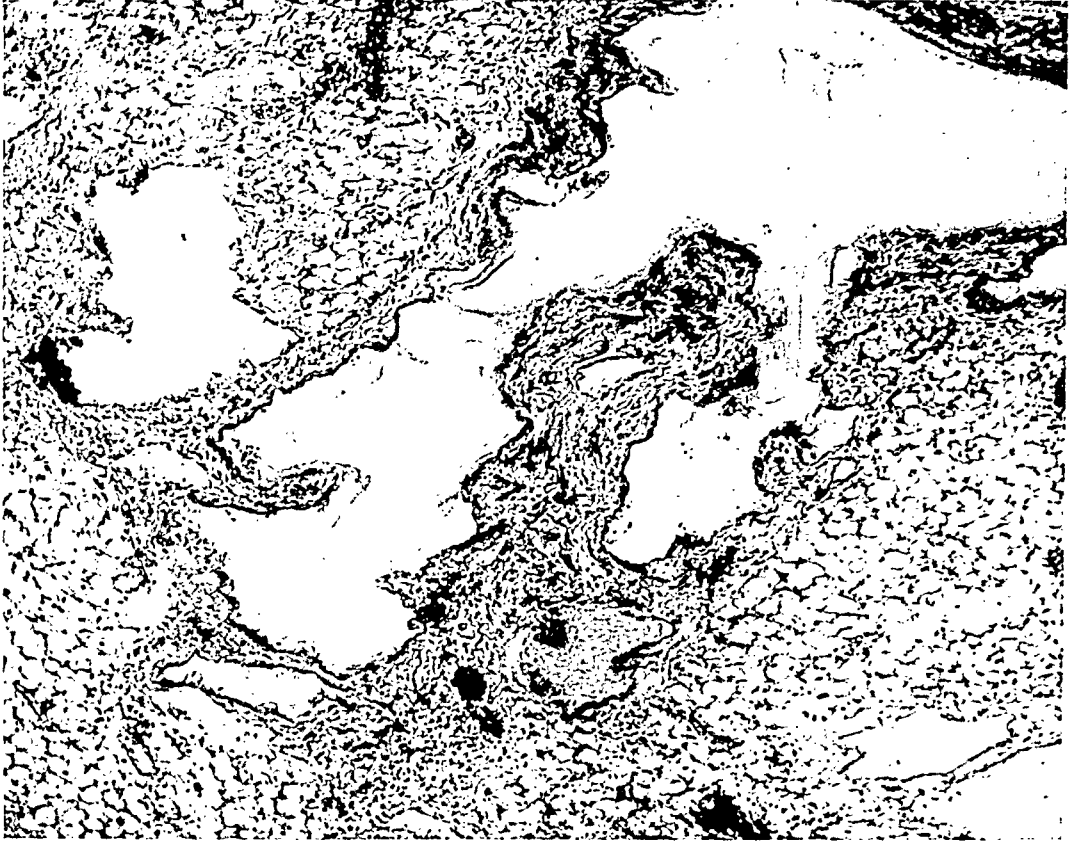


FIG. 4.—Cavernous lymphatic vessels in omentum. "Cystic lymphangioma." Lymph stasis. Slight inflammatory infiltration of omental adipose tissue.

lymph gland in the sense of deficient proliferation of the mesenchyma which constitutes the septa, this deficiency substituting a cystic cavity with lymph contents for the lymph gland.

Such a mechanism of development would explain the formation of cysts in all regions rich in lymphatics, viz.: congenital lymph gland cysts originating from lymph glands in their first period of development.<sup>17</sup>

Grausman and Jaffe "28" report, male forty-four, abdominal mass with pain. Many omental cysts lined with endothelium and supported by connective tissue layer.<sup>18</sup>

They consider their case as a "true blastoma from undifferentiated mesenchyma, which is capable of producing lymphatic vessels by proliferation of lymphangio-blasts.

"Many of these newly formed lymphatic vessels become enlarged and cystic, due to the blocking of the outlets and possibly because they are blind

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secondary changes such as dilatation and proliferation of the endothelium. They believe that the preformed lymphatics are not involved in the tumor growth."

*Comments.*—The findings in this case show a primary true lymphangioma of the omentum. The direct cause of cystic development, a fibrosis of the gastro-colic and gastro-splenic omentum. What caused this fibrosis is indeterminate.

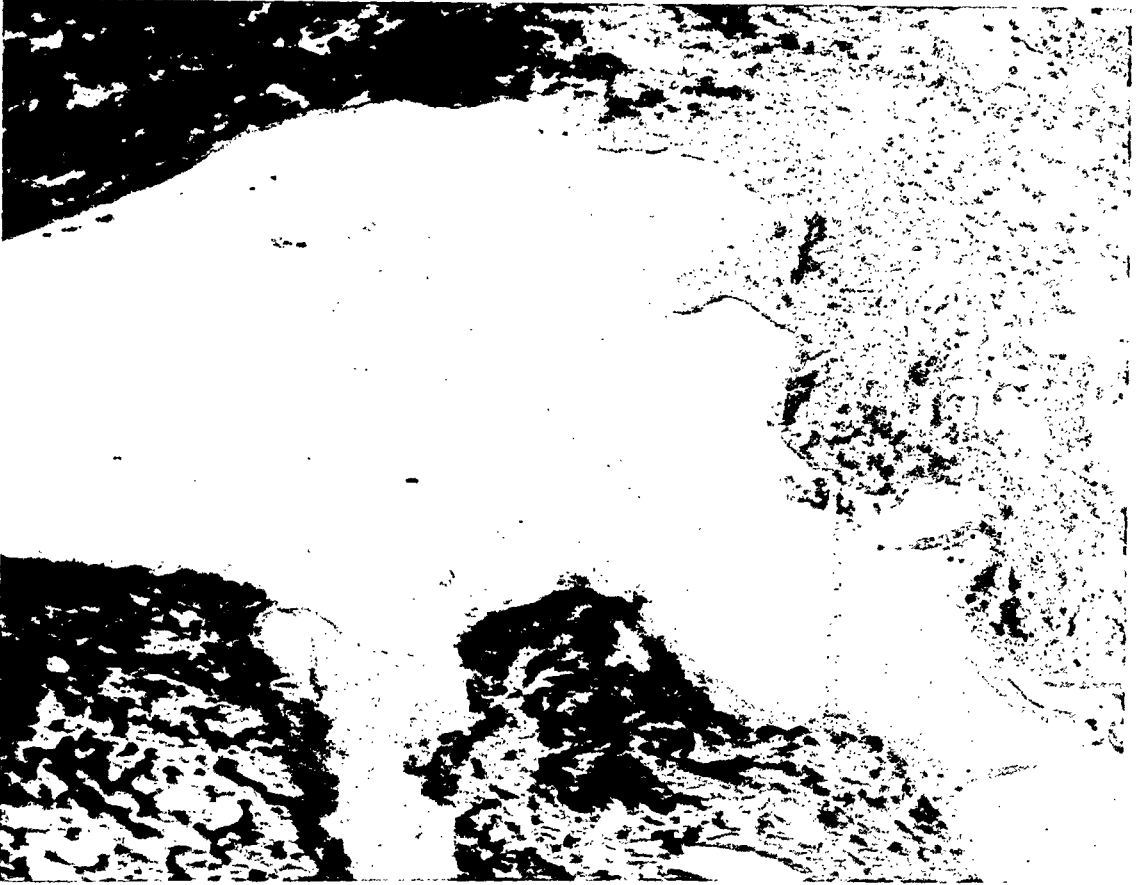


FIG. 5.—Higher power photomicrograph of portion of wall of cystic lymph vessel in omentum, showing lymph content about the wall and endothelial lining.

The history of case is negative except chronic infective tonsillitis. No abnormalities existed in the thorax that would have a bearing on this cystic development of omentum, such as tumors in the mediastinum, or obstruction of thoracic duct due to inflammations, thrombosis of the left brachiocephalic vein, or of tricuspid insufficiency, which would produce backward pressure of blood in the subclavian.

While in doubt as to etiology, should this case be dismissed as one of congenital origin, embryonic rests, malformations, or defects?

Various structures of the body are affected by microorganisms of hæmatogenous origin from different foci of infection.

The effects produced are dependent upon the varying types of organisms of their virulency, of structures involved, and of the resistance of person.

Connective tissue change is concomitant of infection. Chronic infective tonsillitis may involve any organ or structure in the human body.

The supposition arises in this case of the hæmatogenous origin from this foci of infection, the organism having a selective action upon the gastro-colic and gastro-splenic omentum; at first inflammatory in character, the end result of which, the formation of dense fibrous tissue. This fibrosis then producing a stasis and obstruction of the lymph circulation in the omentum, and the consequent formation of three large, and many small, omental cysts. *Pari passu* with the increase of size and weight of the cysts, the pull and traction upon the inflamed gastro-colic and gastro-splenic omentum, tend to increase the development of fibrous tissue.

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# LYMPHOSARCOMA OF THE MESENTERY

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TUMORS of the mesentery are rarely encountered. Julian L. Rawls,<sup>1</sup> in a search through medical reports, has found about two hundred cases of cystic tumors of the mesentery and one hundred cases of solid tumors, to which he adds two cases of his own, one being a tuberculosis of the cæcum, and the other, a fibroma. Harris and Herzog<sup>2</sup> collected fifty-six cases of mesenteric tumor in 1897. In 1905, Vance<sup>3</sup> collected twenty-eight cases which appeared in the literature of the preceding five years, H. G. Kyle<sup>4</sup> reported a case of fibroma of the mesentery in 1921 and, in searching the literature for the past ninety years, found report of only thirty-two tumors of like nature. Lipomas of the mesentery, according to B. A. Alton,<sup>5</sup> are the most common solid tumor of the mesentery. In 1918, Bevan<sup>6</sup> of Chicago reported a huge fibroma of the ileocæcal junction.

In a review of the literature since 1920, we have found reports of twenty-five cases of solid tumor of the mesentery. Of these, eight were definitely sarcomatous in nature, eight were lipomas and in nine cases the exact diagnosis was not definitely stated.

Lymphosarcoma is the most common type of malignant tumor occurring in the mesentery. It is a growth arising in the lymphoid tissue; it is somewhat more restricted locally than is Hodgkin's disease or pseudo-leukemia; it possesses greater invasive tendencies than either of these diseases but is without marked malignancy at least as indicated through the blood stream, according to Nelson.<sup>7</sup> Delafield and Prudden<sup>8</sup> state that the tumor consists primarily of lymphoblasts and agree with Ribbert,<sup>9</sup> the name should properly be "lymphoblastoma." These authors state that in the metastasizing lymphoblastoma characteristically follows the lymph channels, at first spreading along them from one lymph-node or follicle to the next, but finally invading the surrounding structures, until all are fused into one firm mass. It progresses from one region to another without ever becoming generalized as do leukemia or pseudo-leukemia. Metastasis by way of the blood stream is rare. In differential diagnosis it is stated that the lymphoblastoma may be distinguished from the large round-celled sarcoma by the lack of a proper stroma, its early limitations to the lymphatic system, the capillary size of its blood-vessels, the absence of hemorrhage, and its tendency to metastasize in organs ordinarily spared by malignant growths.

Nelson<sup>7</sup> states that lymphosarcoma occurs in males twice as often as in

females; that it may occur from infancy to old age; that the differential diagnosis is extremely difficult and is rarely made, and that the prognosis is uniformly fatal.

**CASE REPORT.**—T. E. G., male, white, aged eight, admitted to the Children's Hospital on March 5, 1927, showing a marked distention of the abdomen. The family and social history were negative. Three weeks previously the child, immediately after breakfast, was seized with an attack of vomiting, accompanied by abdominal cramps. Nothing could be ascertained upon physical examination, the vomiting being the only indication of abnormality. Six days after the attack the mother noticed some distention of the abdomen which increased daily. The bowels moved with laxatives.

*Physical Examination.*—Showed an abdomen markedly distended, skin tense, and a few prominent veins over the upper part. Percussion revealed an area of tympany over the epigastrium, the remainder of the abdomen being dull. Dulness shifts slightly with change of position. No succussion sounds are heard and no fluid wave is noted. There was no rigidity. There was a small area of tenderness in the upper left quadrant. No masses were palpable or visible. On rectal examination there was the same feeling of tension that was noted over the abdomen. No tenderness on rectal examination, but a mass was felt high in the left side. X-ray of the chest showed a slight peribronchial infiltration. X-ray of the abdomen showed a possible mass, the size of an orange, to the left of the midline. The urine was negative. The blood picture showed: Red blood-cells, 3,000,000; hæmoglobin, 70 per cent.; white blood-cells, 10,100.

It was thought that the condition might be due to tuberculous peritonitis, but no pre-operative diagnosis was made, and the operation advised was frankly exploratory.

A four-inch median vertical incision was made below the umbilicus. The peritoneum at the upper angle of the incision was thin, but it was quite thick below, suggesting tuberculosis. A small amount of free, odorless, fluid escaped (culture from this showed no growth). An enormous omentum was then delivered. It was thick, had a granular feel and was friable. With the omentum delivered a dumb-bell shaped mass was felt in the upper abdomen which proved to be a tumor of the mesentery, the size of an adult fist. The growth had extended to the wall of the small intestine above. No effort was made to resect, as the entire mesentery of the small intestine was shot full of similar small masses. A small piece of the parietal peritoneum was cut away for examination, much of the omentum was removed and the wound was closed without drainage. The child was put to bed in poor condition, and died within an hour. The operation was classified as "Exploratory laparotomy for sarcoma of the mesentery, small intestine, and omentum." This operative diagnosis was confirmed by the pathological findings which follow:

*Autopsy Report No. 3863.*—May 7, 1927, surgical service, Dr. Leslie L. Bigelow, pathologist, Dr. Ernest Scott. Upon opening the abdomen the omentum is immediately seen to be greatly increased in amount, and upon closer examination it is seen to consist of its usual thin membrane which is traversed by pale, apparently cellular streaks; these streaks or masses of cells are arranged in a somewhat definite network closely resembling the distribution of the normal fat over the omentum. Upon drawing the omentum forward it is found that not all of the omentum was at first visible but a large quantity was tucked away in the lateral portion of the abdomen and in the pelvis. When the omentum is entirely assembled it forms a large mass 20 x 25 cm. and is unusually friable. Upon examination the intestinal tract is found to be free and of normal appearance with the exception of one area in the jejunum, where there is a distinct nodule measuring 3½ cm. in diameter, involving the larger portion of the intestinal wall; immediately adjacent to this there is a second mass of equal size lying within the mesentery. Upon section the lumen of the intestine is found not to be constricted and it is found that the tumor mass does not involve the mucous surface. The tissues of the tumor are of uniform pinkish color and slightly friable. The mesenteric lymph-nodes are enlarged and



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near the base of the mesentery there is a confluent mass of nodes. Upon section these nodes present the same pinkish color and are friable similar to that noted in the tumor attached to the intestines. The liver is of the usual size, but along its inferior margin there are several whitish nodules standing out somewhat conspicuously from the liver substance and measuring  $2 \times 2\frac{1}{2}$  cm. in diameter. On section through one of these nodules it presents the same appearance and characteristics of the nodules in the mesentery. Upon removal of the liver examination of its surface reveals other and somewhat larger nodules imbedded in its substance, one of these masses of tumor tissue corresponding in size and shape to the gall-bladder, on section presents a yellowish discoloration resembling a bile-stained mucous membrane. The impression is gained that the gall-bladder has been so infiltrated by the tumor mass that its lumen has been almost completely obliterated and only a small portion of the bile-stained mucosa remains. Examination of the kidneys, adrenal glands, ureters and bladder fails to reveal any evidence of pathologic change, or of metastatic nodules. Examination of the spleen and pancreas also give completely negative results. Examination of the thorax is entirely negative. The anatomical diagnosis is sarcoma of the mesentery with metastasis in the omentum, the wall of the jejunum, the liver and the gall-bladder.

*Microscopic Examination.*—The cell is typical of the lymphoblastic type. Many mitotic figures are present. There is a marked metastasis into the liver. The omentum is thoroughly infiltrated and the intestinal wall is involved in one area, the cells having infiltrated to the submucous layer. There is a retroperitoneal infiltration adjacent to the attachment of the mesentery.

### DISCUSSION

The mortality following operations for solid tumors of the mesentery, with or without resection of the intestine, is high. The prognosis of lymphosarcoma is, according to Nelson<sup>7</sup> universally fatal. It is his belief that any surgical treatment is merely palliative. However, according to Bigelow and Forman,<sup>10</sup> early surgical removal of the involved glands may be followed by recovery. It is their belief that when but one leaf of the mesentery is bulged and the intestinal wall is not involved, the tumor mass may be enucleated without dangerous interference with the blood supply. If the tumor mass is more centrally placed, bulging both leaves of the mesentery, or if the intestine is adherent to the growth and involved in the process, resection should be done at once. Harris and Herzog,<sup>2</sup> Sawyer, Mathews, and others, report successful removal of mesentery sarcoma combined with enterectomy.

The case here presented is the second encountered by one of us, the first being in July, 1919. This adds another to the short list of mesenteric sarcomata. It is regional in type, and has no history to which can be attached etiological significance. The case conforms to the established picture of regional lymphosarcoma. The size of the mesenteric tumor, as compared with other involved regions, leaves little doubt that the sarcoma arose in the mesentery.

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- <sup>10</sup> Lymphosarcoma (L. L. Bigelow and J. Forman): *ANNALS OF SURGERY*, vol. lxxi, p. 11, January, 1920.

# BRACHIAL PLEXUS ANÆSTHESIA

## ITS INDICATIONS, TECHNIQUE, AND DANGERS

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WITH the rich clinical experience of Prof. Heinrich Braun showing the safety of novocain-adrenalin solution in local anæsthesia, a new impetus was given its use. Anæsthesia of the trigeminus, median and ulnar nerves was an established possibility; the logical question presented itself; why not a complete brachial plexus anæsthesia to open the way for a vast amount of surgery of the upper extremity without the use of a general anæsthetic? Essentials to this accomplishment were fundamentally two: exact knowledge of the location of the nerve trunks which were to be injected, and the particular avoidance of injury to any of the vital structures in its immediate neighborhood. A careful anatomical study of the trunks forming the plexus showed that the best location to reach them with the needle was in the immediate neighborhood of the subclavian artery where it passes over the first rib, the latter serving as an efficient barrier to deeper penetration by the needle. Here, too, as an added advantage for the site, all the branches of the plexus could be anæsthetized through one injection. The proximity of the subclavian artery gave only mild cause for concern, for one of us (D. K.) has proven clinically on numerous occasions, that a thick-walled artery like the subclavian could be punctured with impunity by a thin needle such as is used in this work. The structure which caused more concern was the large subclavian vein, because of the fact that even a few c.c. of a  $\frac{1}{2}$  per cent. solution of novocain injected into a vein so close to the head is quickly productive of a serious novocain poisoning. But the position of the vein, lying as it does, medial and in front of the artery from which it is separated by the lower part of the scalenus anticus muscle, affords it a reassuring degree of protection. (Figs. 1 and 2.) The apex of the lung was another structure which gave no small cause for concern; but again the first rib plays an important part in affording protection to it. Needless to say, a clear and definite mental picture of the anatomy of this region is absolutely necessary to the proper accomplishment of the anæsthesia in question. We have then, as limiting the field in which to work, these structures: the clavicle marking the lower limit, the first rib, the upper, and the subclavian artery (determined by its pulsations) the outer limit of safety. The first attempt at plexus anæsthesia by the route to be described was made by Professor

Kulenkampff on himself. (Fig. 3.) It was by this means proven that the route was a safe one of approach to obtain an anæsthesia for the hand, forearm and arm. Previous attempts at plexus anæsthesia had been made by Hirschel,<sup>3</sup> his route of approach being through the axilla. There, too, the plexus is somewhat superficial and orientation to it gotten by the axillary artery; but the many disadvantages to this approach as well as its failure to

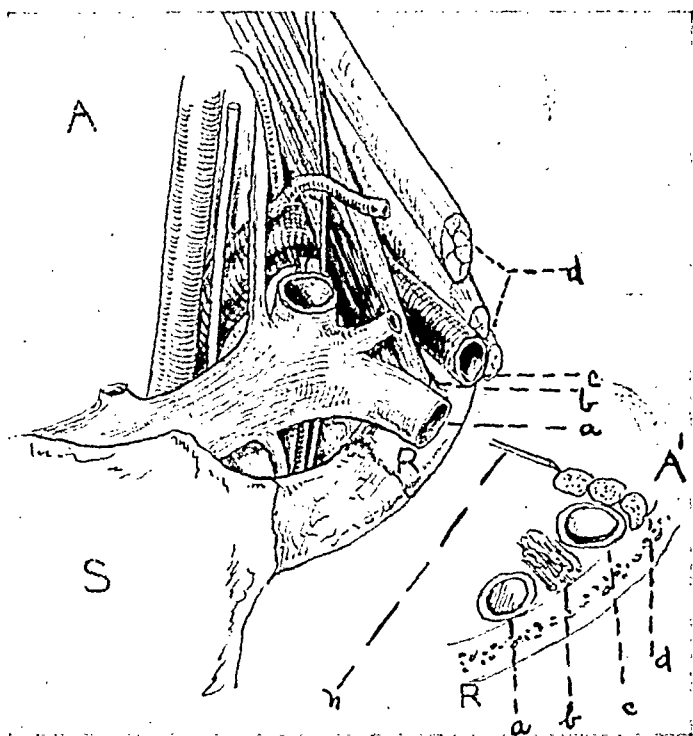


FIG. 1.—A and A': a: subclavian vein; b: scalenus anticus muscle; c: subclavian artery; d: cords of brachial plexus as they cross 1st rib; S: sternum; R: 1st rib; n: needle.

anæsthetize many of the branches taking origin above the axilla, failed to secure for it any degree of popularity. Working on this supraclavicular route Perthes<sup>4</sup> attempted to simplify the technic by using a mild electric current to stimulate the plexus when the needle was thought to be in proper position, and thus give proof as to its location. Another modification of plexus anæsthesia came with Mulley's<sup>5</sup> work. He selected a point about three fingers' breadth above the clavicle as the entrance point for the needle. It is made to enter

$\frac{1}{2}$  cm. posterior to the external jugular vein and from this point attempts to locate the plexus are made. But in this route the danger of injury to the apex of the lung and to the deeper structures of the neck are very great, as the protecting first rib is not utilized in this method. Hohmeier<sup>6</sup> and Balitzky<sup>7</sup> have devised an infra-clavicular route of approach. In this technique the needle is entered  $\frac{1}{2}$  cm. under the midpoint of the clavicle and passes upward and inward; after piercing the pectoralis major the plexus is encountered from 2 to 5 cm. further inward. Still another modification was that of Capelle<sup>8</sup> using the Hirschel technique as a basis. He injects 20 to 30 c.c. of novocain solution in the bicipital sulcus, depositing the solution around the artery. The foregoing is a brief review of the progress made in the work of plexus anæsthesia.

#### INDICATIONS

Practically all conditions of the upper extremity which necessitate operative procedures, lend themselves to plexus anæsthesia. As the needle in this type of anæsthesia does not enter the infected area, no concern need be felt

rectus muscle. The Hancock incision which runs parallel and close to the crest of the ilium above and to Poupart's ligament below, cuts across the bellies of the oblique muscles and often severs the twelfth thoracic and ilio-hypogastric nerve. We use routinely the transverse incision of G. G. Davis (Figs. 5 and 6). It permits excellent exposure and cuts no muscles or nerves. The incision is so uncommonly used, yet has such obvious advantages, that I will give briefly the technic. It is on a line which extends from the anterior-superior spine of the ilium to the linea alba. The incision is usually 6 to 8 cm. long and centres on the linea

semilunaris. It may be made at a higher or lower level than this should the appendix be previously located in other than its usual position. The skin and subcutaneous tissues are cut, exposing the aponeurosis of the external oblique and the anterior sheath of the rectus. These are split in the direction of the skin incision and the rectus retracted inwardly, thus putting on a stretch the internal oblique and transversalis muscles

which are split outwardly in the direction of their fibres. The posterior sheath is then split transversely inward as far as needed, and the peritoneum opened for the length of the incision. The twelfth thoracic nerve is sometimes encountered running nearly parallel with the incision, but injury to it is obviated by pushing it to one side. When better exposure is needed the incision may be extended outwardly to the anterior superior spine and inwardly to the linea alba. It is never necessary to cut across the rectus, it can always be retracted medially. At a much higher level this incision may be used for operation upon the gall-bladder, but I do not believe it gives as good an exposure as the one used by us which was previously described. On the left side this transverse incision may be used for splenectomy. I have used it in three such cases. Here, however, it is necessary to cut across the rectus in order to get sufficient exposure. When drainage is necessary it is best to let the drain emerge near the linea semilunaris rather than through the bellies of the oblique muscles.

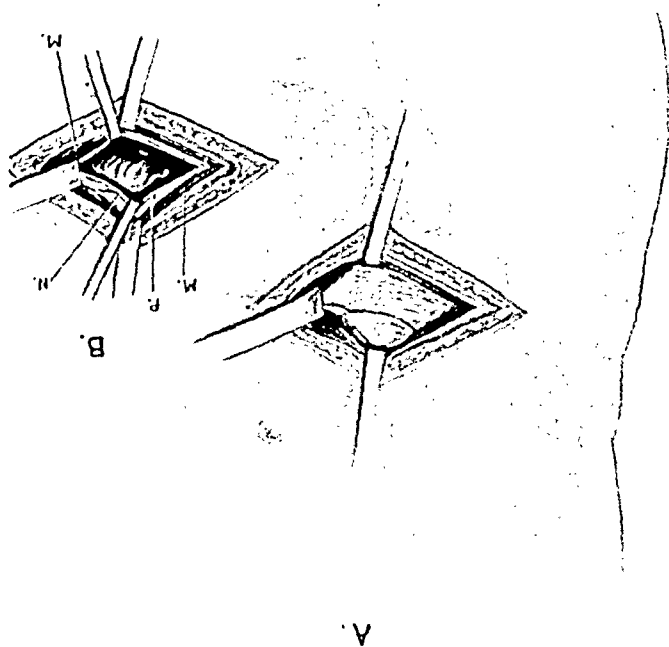


FIG. 6.—A. Internal oblique split exposing twelfth thoracic nerve. B. Nerve pushed aside—peritoneum opened.

for spreading the infection if it is a pus case. In general, one can say that every injury of this region, whether mechanical or bacterial, is suited for plexus anæsthesia. It is especially valuable in the numerous hand and forearm injuries to which the diversified callings of the worker expose him, such as amputations, disarticulations and fractures. Operations on tendons and tendon sheaths offer a major field for the application of this method. In shoulder dislocations it is invaluable. As in local anæsthesia in general, a patient who stamps himself as unfit by his general reaction to the preliminaries attending the actual anæsthesia, is best operated on under a general anæsthetic. In some minor operations of the hand or forearm where the type of injury

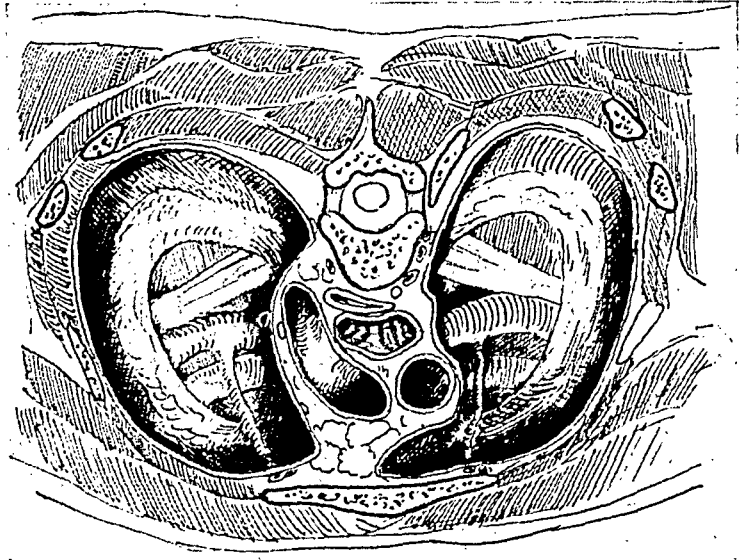


FIG. 2.—The plexus and related structures (after Conning).

is slight, it is not worth the time or energy to do a brachial block; such cases are best treated either by a localized injection or under a general anæsthetic.

#### TECHNIQUE

A *sine qua non* to a proper technique is a clear mental picture of the relation of the structures as they lie under the skin, and a keen sense of direction in which the needle is to be pointed; this is such, as if one wished to strike the tip (spinous process) of either the second or third dorsal vertebra. (Fig. 6.) The point of the needle's entrance is over the midpoint of the clavicle, just external to the external jugular vein; the latter can definitely be brought into view by asking the patient to close his lips and puff his cheeks. Finally came for decision the strength of solution to be used, and the possibility of injury to the nerve trunks by the penetrating needle. Both of these considerations could be definitely answered through the accumulated experience which this hospital has afforded. As to solution: a 2 per cent. novocain-adrenalin was found the most effective; and as for nerve trunk injury, at no time have any clinical signs of permanent nerve injury been found as a result of this type of anæsthesia. The kind of needle used has been of great importance. We have used one 35 mm. long and .5 mm. thick; occasionally one 45 mm. long and .6 mm. thickness has been found practical. The injection is best carried out with the patient in the sitting posture, an ordinary chair suffices. The arm on the side on which the plexus is to be anæsthetized lies quietly in the lap with the shoulder relaxed. (Figs. 4 and 5.) This position not only permits of an easy approach to the plexus, but maintains a certain degree of tension

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on it, which helps in its location by the entering needle. Should the patient's condition prevent his sitting up, he is allowed to lie in bed with a pillow under his shoulder blades and his head turned to the side opposite to the one on which work is being done. The operator seats himself on a stool adjusted to a height which will make him most comfortable. The comfort of patient and operator is important, as plexus anæsthesia is often time-consuming. Before beginning the actual anæsthesia the patient is told that he must immediately notify the operator when the plexus is touched by the needle. He will recognize this by experiencing the same sensation as when striking his "crazy" bone. This pain can be demonstrated to the patient by pressure on the ulnar nerve in the sulcus between the humerus and ulna; in thin people, the supraclavicular portion of the plexus can be rolled under the finger with its consequent tingling sensation.

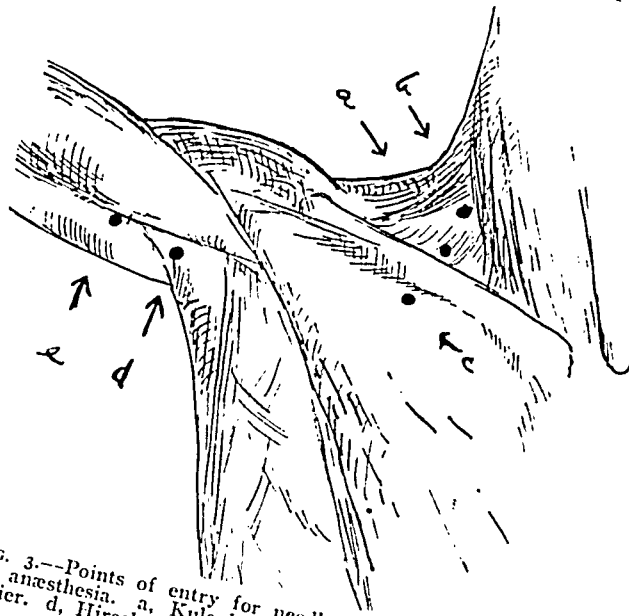


FIG. 3.--Points of entry for needles in different routes of plexus anæsthesia. a, Kulenkampff. b, Mulley. c, Babitzky-Hohmeier. d, Hirschel. e, Capelle.

It is for this type of sensation that the patient must also be warned against suddenly drawing back from the needle as it penetrates the plexus. The solution is then slowly injected. With the index fingers of the right and left hands the sternal and acromial ends of the clavicle are determined. This point is just external to the external jugular vein. Medially to the iodine mark the fingers press gently into the tissues over and close to the clavicle, and thus determine the pulsations of the subclavian artery. The first rib is now located by pressing the fingers into the supraclavicular fossa; this becomes increasingly difficult with the fatness of the patient. With the type of needle already described a wheal is made over the spot through which the needle is to penetrate. The needle, never with the syringe attached, is then forced through the skin and fascia of the neck, great care being taken to avoid the external jugular vein. The cheek blowing manœuvre already mentioned can be used here to considerable advantage. With care the needle is pushed into the skin for  $\frac{1}{2}$  to 1 cm. in the general direction already described. As soon as the characteristic tingling is felt by the patient the needle is held stationary, the syringe attached to it, and the novocain slowly injected. If one has successfully impinged upon the cord of the plexus a sense of resistance

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is felt during the injection of the solution, which differs markedly from that felt when the needle is in loose subcutaneous tissue. The paræsthesias also increase momentarily until the action of the novocain causes its disappearance. The median nerve is usually first touched with the needle as it is most superficial, and then the radial which is behind it. One can now continue to inject the rest of the plexus. It is very helpful, if from time to time one lets the needle lie loose in the tissue and to observe if it is moved by the pulsation of the underlying subclavian artery. This manœuvre confirms the correctness of the needle's direction, and also warns us of the proximity of the large vessel. If the needle strikes the first rib without having produced the characteristic paræsthesias in the finger tips, it is certain that it has not been introduced in the proper direction; under such conditions the needle is withdrawn and re-inserted with its direction somewhat varied. The plane in which the needle enters the tissues should be at right angles to the trunks of the plexus, as in this way the chances of striking them are at their best. If one has directed the needle too far medially, then the subclavian artery is likely to be penetrated; if this occurs a definite sense of resistance is felt, and bright red blood will flow through the needle. This emergency is met by the immediate withdrawal of the needle 2 to 3 mm. to bring its point out of the lumen of the vessel and with the injecting of a little of the novocain-adrenalin solution into the tissues about the artery, which hastens the closure of the vessel. At times a little pressure with a piece of gauze over the artery is used in addition. We have never seen any harm result from this type of vessel injury. The omo-hyoid muscle, as it lies over the nerve trunks, can occasionally prevent a successful plexus block; in such a case, by a slight motion of the shoulder, the muscle can be brought into relief and the needle passed under it.



FIG. 4.—Plexus anæsthesia in sitting posture. The direction of the entering needle is well shown.

### DURATION OF THE ANÆSTHESIA AND STRENGTH OF SOLUTION

In general, the anæsthesia lasts from two to three hours, the strength of the solution having a determining effect on this. Our first work in plexus anæsthesia was with 25 c.c. of a 2 per cent. solution\* (10 c.c. in children). Then for a long time we used 12½ c.c. of a 4 per cent. solution which proved very satisfactory and gave anæsthesia lasting from three to four hours. At the present time 25 c.c. of a 2 per cent. solution is most frequently used. It has been found that the greater the degree of shock and the greater the

\* Novocain solution to which is added 2 drops of adrenalin to each ounce.



loss of blood, the weaker the solution that could be used with satisfactory results. One must not expect to compensate a poor technique in injecting the plexus with the use of a stronger solution than usual. Basically, the duration and effectiveness of the anaesthesia depends on the exactness with which the plexus has been blocked. One can differentiate three degrees of anaesthesia: (1) The deepest type leads to complete loss in the use of the arm; unless the patient assures himself of the fact by visual evidence, he is unaware of pos-

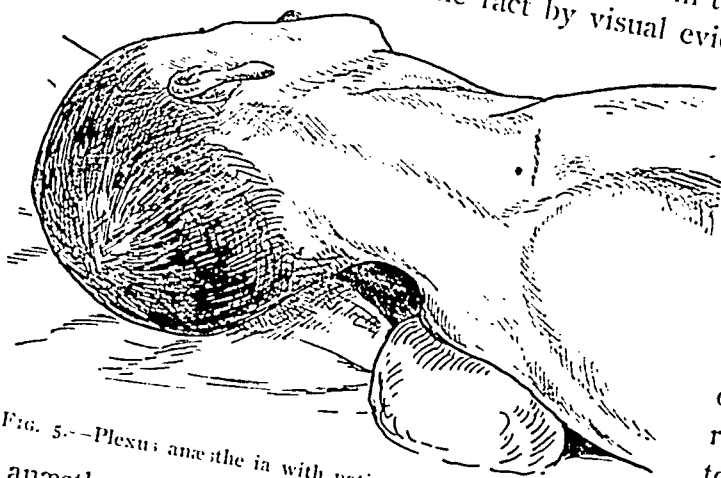


FIG. 5.—Plexus anaesthesia with patient in recumbent position.

sessing an upper extremity; motor, sensory and kinæsthetic senses are lost; this type of anaesthesia is ideal and therefore only infrequently obtained; (2) in this degree of anaesthesia one obtains a deep motor paralysis with insensibility to pain but without complete loss of kinæsthetic senses; (3) in this degree of anaesthesia the injection has been but indifferently done, but one still gets a sufficient degree of anaesthesia to permit of some operative procedures, provided the nerves included in the block are the ones supplying sensation to the region involved in the operation. Effectiveness of the anaesthesia is evidenced by a heaviness of the arm and forearm with a decrease in any previous pain. Ataxic movements of the arm when the patient attempts purposeful movements, is another manifestation of the anaesthesia. The supraclavicular nerves which to some degree supply the upper arm with sensation are completely eliminated, only, if at the same time that plexus block is induced, these nerves too are anaesthetized, by injecting them at the posterior border of the sternocleidomastoid muscle.

#### UNTOWARD EFFECTS AND DANGERS

Because of a possible paralysis of the large nerve trunks incident to this type of anaesthesia, vasomotor reactions lead to a plethora of arm, forearm and hand. It does not as a rule lead to any disturbing features. The explanation of this phenomenon is probably as follows: the novocain solution is injected in such proximity to the arteries that it has a paralyzing effect on the small nerves penetrating its arterial coats, with a consequent dilatation of the artery and an increased blood supply to the parts. The sympathetic fibres on that side of the neck receiving the injection are occasionally involved; this manifests itself clinically by a hyperæmia and perspiration on that side of the face. Partial and temporary paralysis of the phrenic nerve is another possibility which manifests itself by weakened movements of the diaphragm on the affected side. Haertel and Keppler<sup>9</sup> by fluoroscope

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control have demonstrated this condition. Fear of injury to the apex of the lung is not without its foundation. Capelle<sup>8</sup> reports one of the first of such occurrences—an emphysema of the lungs, following penetration of the pleura and lung substance by the needle. Further such occurrences have been reported by Brunner,<sup>10</sup> Klauser,<sup>11</sup> and Siebert.<sup>12</sup> Kulenkampff has reported on the train of symptoms attendant on such an accident: dyspnœa, chest pain, sense of chest oppression and sometimes slight cyanosis. Permanent or partial damage to the plexus has also been reported by Borchers,<sup>13</sup> Haertel,<sup>14</sup> Hirschler,<sup>15</sup> Keppler,<sup>16</sup> Flesch - Thebesius.<sup>17</sup> Haertel himself, however, considers the cause of this trouble not yet clearly defined. In this clinic we have never seen any serious damage to the plexus resulting from this type of local anæsthesia. We have on occasions seen

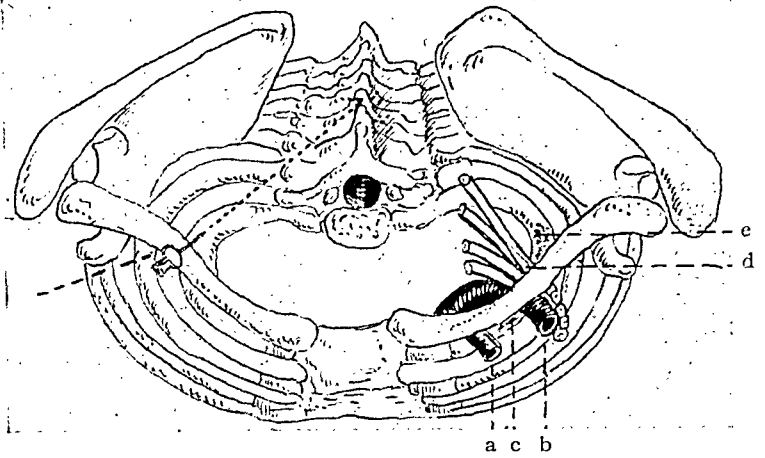


FIG. 6.—The plexus and related structures as seen from in front and above. Compare with Figure 1. Note well the direction of the entering needle, which, if long enough would strike the tip of the 2nd and 3d dorsal vertebræ.

irritation of the plexus due to the needle passing beneath the first rib and coming into contact with the pleura. At no time has damage to the lung been observed. One should be particularly careful of this complication in the emphysematous patient because in him the apex of the lung is, because of its distention, in nearer apposition to the plexus than is normal. Another thought to have in mind with these patients is that the inflated apex may also raise the level of the clavicle and in this manner cause the needle to take a false direction in seeking the plexus. Paralysis of the arm following a brachial block has never been met with in our experience. The involvement of the sympathetic and phrenic nerves have already been discussed and are without significance. Not infrequently patients will show a marked reaction following the injection of the solution, especially when the injection is made about the head or neck. The patient will show palpitation, marked pallor and restlessness. We believe this reaction to be due, not to the novocain, but to the adrenalin. The symptoms are similar to those seen when adrenalin is given to a patient for an acute attack of asthma. While the omission of adrenalin slows the effectiveness of the anæsthetic, it dispels the fear and anxiety which this reaction arouses in some patients. At this hospital, 1000 brachial plexus anæsthesias have been given since 1911. It is felt that this is a fairly large number on which to base an opinion as to the effectiveness of this procedure.

### SUMMARY AND CONCLUSIONS

The supraclavicular method of plexus block is teachable and learnable. It eliminates pain from the arm, forearm and hand, and produces a motor

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and sensory paralysis directly proportionate to the degree of skill with which the anaesthesia has been produced. One can inject the nerve trunks successfully, provided their location external to the subclavian artery and its relation to the other anatomic points is carefully visualized. The first rib marks the deepest point of needle penetration. The direction of the entering needle should be such as if one wished to strike the spinous process of the second or third dorsal vertebra. After striking the median nerve (the desideratum in plexus anaesthesia) as manifested by tingling and various paræsthesias in the finger tips, 25 c.c. of a 2 per cent. solution of novocain-adrenalin are slowly injected. Within ten to twenty minutes anaesthesia is complete. If one is working high up on the shoulder or in the region of the axilla, the intercosto-humeral nerve, a branch of the second intercostal, must be blocked. In careful hands plexus anaesthesia is practically without danger. Care must be taken to avoid injury to the apex of the lung, the external jugular vein, and subclavian artery. To avoid injury to the cords of the plexus a very fine calibre needle is to be used. Puncture of the subclavian artery, while not a desirable accident, should cause no fear; the immediate withdrawal of the needle into the surrounding tissue with the injection of the novocain-adrenalin solution will hasten the closure of the artery; the needle is then withdrawn and compression with a piece of gauze maintained for a few moments. Occasionally there is paralysis of the phrenic nerve or sympathetic of the neck; both conditions are temporary and without serious consequences. The duration of the anaesthesia is from two to four hours. In many cases this anaesthesia can be used for the inspection of painful injuries preliminary to any operative work. Plexus anaesthesia is practical, has well defined usefulness, and can be utilized even in cases where a general anaesthetic would but add to an already existing shock.

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## MELANOTIC TUMORS\*

NONMELANOTIC MELANO-EPITHELIOMAS AND THEIR RELATION  
TO THE MELANO-EPITHELIOMAS

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FROM a morphologic standpoint there are three main contentions relative to the origin of melanotic tumors:

1. They arise from the epidermis.
2. They are of mesodermal origin.
3. They are specially characterized cells of mesodermal origin, so-called chromatophores.

Ewing's noncommittal view is tersely expressed: "Theoretical considerations favor the origin of all melanomas from the mesoblastic chromatophore, while histology favors their origin from epithelial cells which have taken on pigmentary function."

More recently investigators have attempted to settle the controversy by study of the embryology, but again, they too differ in their conclusions. Acton in his embryologic studies on the tree frog concludes that in lower animals the melanoblasts form a large continuous sheet under the skin surface layer (primitive pigment sheet) which is closely related to the angioblasts of the cutaneous respiratory capillaries.

Acton believes that the melanoblasts (which form pigment) are primarily in the dermis, and that processes from these cells envelop the basal cells of the rete malpighii, and the pigment diffuses between the cells into the intercellular bridges. He finally concludes that there are two types of cells involved in the melanotic tumors: (1) melanoblasts, giving rise to melanosarcoma, and (2) angioblasts (which with the melanoblasts form the benign moles) giving rise to malignant endotheliomas.

Spencer is a strong protagonist of the epidermal origin of the melanotic tumors. His observations on the ink-sac of the sepia show that epithelial cells form melanin pigment. He further observed that in embryo frogs branched pigmented cells develop in the epidermis and pass downward into the subepithelial tissues. This is in direct contradiction to Acton's observations.

Spencer, in his studies on the eye, states that the pigment of the choroid is developed from the retina either by the ingestion of pigment by the cells of the choroid acting as phagocytes, or the cells have grown down into the choroid from the retina. He explains the distribution of melanin-pigmented

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\* Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Surgery, September, 1926.

cells in the body by the fact that primarily they developed around the neural tube for protection of the central nervous system. As further development occurred, the pigmented cells first spread into the epidermis and then deeper into the mesoblast of the immediate neighborhood and were then carried along the parietal and visceral layers of the mesoblast along with the outgrowing nerves, especially the sympathetic nerves. Pigment cells, therefore, are present in the epidermis, in the rete malpighii and to a less extent in those of the rete spinosum and the corresponding epithelial cells which produce shafts of hair. While in the dermis, the pigmented cells may occur singly, in patches, or in sheets at varying distances from the epidermis, but they all originate as dendritic cells which have penetrated from the epidermis downward into the dermis either as melanophores (cells that are pigmented) or as melanoblasts (colorless cells) that become pigmented in the dermis. The epidermal cells make the pigment while the mesoblastic cells take up the pigment freed by the breaking down of epithelial cells, as phagocytes.

Smith states that there are two types of melanotic tumors: those arising from the skin, hair follicles, retina, and certain regions of the brain are epithelial in origin while those from the iris and choroid and the "mongolian spot" (pigment spot found over the sacrum in the dark races) are mesothelial in origin.

Dawson gives an admirable review of the various theories of origin of the melanomas, and from his studies concludes that melanotic tumors are epithelial in origin. But he agrees with Broders and MacCarty that it is not necessary to accept Unna's view that nevi are epithelial cells snared off in early embryonal life. He believes rather that the difference in morphology should be regarded as an expression of their capacity for differentiation. Therefore, the changes in the epidermis are the different stages of a process "uniform in its initiation but manifold in its development"; hence the reason for their mimicking the picture of carcinoma, sarcoma or endothelioma. In this view he refers to Marchand and Adami who pointed out the relationship between the "differentiation and both the proliferative and functioning capacities of cells." He maintains that a great many observers are misled by the fact that both epidermal and mesodermal cells may show pigment. But the epidermal cell is the creator of that pigment and the mesodermal cell is only a phagocyte carrying pigment.

Dawson takes issue with Acton's idea about his "primitive vascular pigment sheet" in the tree frog being mesoblastic in origin, because it represents a more mature stage of pigment formation. He cites Kornfeld who found melanoblasts (in the larval stage) in the epidermis. To regard the primitive pigment sheet in the subepidermal tissues in the mature position of mesoblastic origin "disregards the phases of their migration which are coincident with the phases of metamorphosis of the larval amphibian."

Relative to the choroidal tumors which have been cited as a good reason for believing them to be of mesoblastic origin because the choroid is mesoblastic embryologically, he repeats Spencer's observations as well as his own;

namely, that the retinal pigment cells migrate to the choroid and provide the choroid with pigment. He concludes that malignant melanomas arise from carcinomatous changes in actual nevus cells derived from the epidermis and embedded in the dermis, or from a genetic process starting in the epidermis and progressively undergoing morphologic changes as they migrate into the dermis. He summarizes his ideas as to the many differences in morphology as follows: "These varied series of epithelial cell transformations, resulting in tumors of such diverse types, allow of only one interpretation, that of their epidermal origin and an evidence of the amazing power of anaplasia and redifferentiation of the epidermal cell." This is in accord with the earlier statement of Broders and MacCarty that malignant melanotic tumors are due to the "migratory hyperplasia of the basal (regenerative or germinative) layer of the skin and invades the subcutaneous tissues and distant organs."

*Metastasis of Melanotic Tumors.*—One of the arguments in favor of the epithelial origin of the melanotic tumors is that they metastasize by way of the lymph-channels to the nearest lymph-nodes. But those favoring the mesothelial origin cite the extension of ocular melanomas by way of the blood stream. As a matter of fact both methods of metastasis occur, but more often the lymphatics are involved. It is only when the tumor has grown rapidly that the blood stream is invaded. Miescher applied the dopa reaction to a metastatic growth from melano-epithelioma with positive results, showing that also the metastatic tumor cells are ectodermal in origin.

Acton, who believes in the dual origin of melanotic tumors, asserts that the "melanosarcomas" spread by rapidly eroding blood-vessels while the melano-endotheliomas spread by permeation along the lymphatics.

Cairns describes a primary tumor of the eye with metastasis to the scapula after eighteen years. He says that melanotic tumors frequently reproduce in bone.

Metastasis may occur in any organ, including the heart muscle and the spleen. Tumors of the eye often metastasize to the liver.

*Melanin.*—In order to understand fully why some tumors of the melanotic type are pigmented and some are not, it would be well to review our knowledge of melanin. Melanin is a term given to "a varied and complex group of pigments which give color to hair, skin and eyes in man, and are responsible for the color of animals, birds and insects."<sup>30</sup>

*Physical and chemical properties.*—Ewing states that melanin consists of carbon, hydrogen and nitrogen in the ratio of 1:5:5 and varying amounts of sulphur. Acton says that from 8 to 13 per cent. of sulphur is present while Spencer gives sulphur a content of from 5 to 12 per cent. Melanin contains no iron. Heated in strong alkali melanin from melanotic tumors yields indol, skatol, and volatile fatty acids and ether-soluble acid giving a dark blue color with ferric chloride. The chief product is melanic acid. Under dry heat melanin gives off pyrrol.

*Origin.*—The theories as to the origin of melanin are at wide variance. Some authors claim that melanin originates from the hæmoglobin of the blood.

But melanin does not contain iron unless there has been an extravasation of blood into the tumor. Meirowsky, Rossle and Staffel (according to Acton) believe that the origin of melanin is from nucleolar matter of melanoblasts. The coincidence of increased melanin and nuclear degeneration is taken by them to be a distinct sign of a causal relationship between the two. Lubarsch believes that the high sulphur content of melanin is an indication of the pigment being connected with decomposition of albumin. But Acton refutes the nuclear degeneration theory by the fact that the most virile cells have the most pigment. Spencer believes that the nuclear degeneration is a pressure-effect of the pigment in the cells.

Many substances have been said to be the mother-substance of melanin; namely, tyrosin (Gessard, Dunham), epinephrin (Jäger, Neuberg, Meirowsky, and others) and tryptophane (Spiegler, Eppinger, Fasal, and others).<sup>8</sup>

Until recently the general belief was that melanin pigment was produced by the action of an oxidase (tyrosinase) found in the epidermal cells, on an oxidizable colorless chromogen (melanogen) which is formed by the metabolic activity of the cell from the protein molecule brought to it. The term "melanogen" originated with Thormählen who found that the urine of patients suffering from melanotic carcinoma darkened on standing.<sup>32</sup> Tyrosinase is so called because of its action on tyrosin and other aromatic bodies containing an hydroxyl group to form melanin bodies. Tyrosinase has been found widely distributed in the tissues. Gessard<sup>30</sup> found it in melanotic tumors of the horse. Artificial melanin has been formed by the action of tyrosinase of Lepidopteran larvæ on tyrosin.

Recently Bloch<sup>9</sup> brought out the dopa reaction by treating fresh skin or frozen sections with a 0.1 or 0.2 per cent. watery solution of 3-4 dioxypheynylalanine for twenty-four hours at room temperature, or 37° C. A positive dopa reaction is due to oxidation (with condensation) of the dioxypheynylalanine into a dark (smoky-gray, dark-brown or very black) pigment, the dopa melanin which may be diffuse or in granules. The site of the positive dopa reaction is restricted to the protoplasm (not the nucleus) of the malpighian cells of the basal cell layer (and in stronger reactions also the prickle-cell layer) the infundibulum of the hair follicle (Follikel trichter) and the cells of the outer root sheath and hair matrix. In other words, the dopa reaction is restricted to cells of ectodermal origin.<sup>9</sup> The positive dopa reaction should be distinguished from a pseudo-reaction which is found in the leucocytes and sweat gland cells of the cutis (mesodermal origin) which is due to oxidation of dopa by phenolase or polyphenoloxydase present in these cells. The form of cell which gives a positive dopa reaction may be the normal epidermal cell or, in stronger reactions, a dendritic type of cell with long branching protoplasmic processes which enmeshes the neighboring cells. The intensity of the dopa reaction is proportional to the strength of the dopa-oxydase present in the cells. This varies not alone according to species of animal or race, but also from cell to cell in the same section. Some of the cells may be darkly pigmented, others only slightly, and still others not at all. Thus it is easy to understand that under pathologic conditions the variations may be even more striking; this is well shown in the skin and hair of the albinos and vitiligo spots where the dopa reaction is absolutely negative because dopa-oxydase is lacking in these cells.<sup>7, 10</sup> This is also true in the white hair-spots in animals. The intensity of the reaction may also be changed by physical, chemical and infectious influences. The reaction is more intensive after exposure to sunlight, Röntgen-rays, thorium-x, quartz lamp, and so forth<sup>22</sup>; it is most intensive in the pigmented nevus and is absent in vitiligo spots.

Muscle tissues held apart by drains tend to remain so after removal of the drain resulting in hernia. The aponeurosis when separated by drains are drawn together by the action of their muscles when the drains are removed. The several hernias I have had following this incision have been cases in which drainage was through the outer angle.

In making any abdominal incision, the cut should be perfectly clean; the edges of the muscles, whether separated or displaced, must be well defined. Fraying of the muscle edges by manipulation is to be avoided, and this can be done by first making the incision of sufficient length, and second, by protection of the wound edges. The length of the incision means nothing if made in the proper way.

To secure proper healing of wounds great care must be taken in closure. The peritoneum and its adjacent fascia are drawn together and sutured with a continuous catgut suture, interrupted sutures if there is much tension, so applied as to evert the edges, thus bringing serous surface to serous surface. This insures prompt union and prevents adhesions between scar and viscera. In all except the transverse incision interrupted sutures of a non-absorbable material, preferably heavy silkworm gut, are placed about 2 cm. apart. These sutures embrace all layers down to the peritoneum. The aponeurotic layer is then sutured with chromic gut. The splint sutures are now tied firmly but not tightly. If too tight they defeat their purpose by strangulating the tissues.

It is customary in some clinics for the operator to push his table aside and have the resident close the abdominal wound while he begins another case. This is bad practice. He who begins an operation should finish it. It is safer for the patient, and should something go wrong, the responsibility can be placed.

Not infrequently one hears of or sees reported cases of breaking down of an abdominal wound with evisceration. It is said that it happens to us all at some time during a surgical career, yet I am of the opinion that it is nearly always preventable. The causes of this calamity may be mentioned in the order of their importance. Faulty making and closure of an incision, constitutional diseases with loss of healing power of tissues, infection, and lastly, the too early removal of splint sutures. These should rarely be removed before the tenth day; usually it is better for them to remain in place twelve days or two weeks.

In conclusion, to secure prompt healing and to leave the abdominal wall free of defects, we must have:

1. Due regard for structures of the abdominal wall.
2. Clean-cut incisions without trauma to its tissues.
3. Perfect asepsis.
4. Secure and accurate suturing of the wound in layers.
5. Not too early removal of the splint sutures.



## MELANOTIC TUMORS

Bloch<sup>8</sup> went further to prove that this dopa-oxydase is a ferment, that it is an oxidizing ferment, and lastly that it is a highly specific ferment. This intracellular enzyme is labile and its thermolability varies with the individual and the type of animal. At from 57 to 80° it is weakened and at 100° its ferment action is disturbed. It is destroyed by drying, imbedding in paraffin, ammonium sulphate, dilute ethyl alcohol, acids, alkalis (except in very dilute solutions), proteolytic ferments, strong oxidizing or reducing agents, poisons (such as hydrocyanic acid), ether, chloroform and benzol. Röntgen-rays and ultraviolet rays have very little effect. Distilled water and physiologic sodium chloride solution have a detrimental effect after a time.

Dr. Horwitz.

To prove that dopa-oxydase is specific for 3-4 dioxypyphenylalanine Bloch attempted to obtain a positive dopa reaction by using other chemical agents allied to dopa. These substances were divided into two groups, those without and those with a pyrocatechol nucleus. Among the many substances without a pyrocatechol nucleus were tyrosin, hydroquinol, homogentisic acid, tryptophane and others. Among those with a pyrocatechol nucleus were pyrocatechol itself and many substances which were assumed to be intermediate to dopa. All these substances gave a negative dopa reaction and warranted the following conclusions about the substance acted on by dopa-oxydase. (Fig. 1.)

1. It must be a pyrocatechol derivative.

2. Both hydroxyl groups in the dopa must be intact, since substitution by a methoxy group gave a negative dopa reaction.

3. The side-chain must have at least a propionic acid group and an amino group.

This showed that 3-4 dioxypyphenylalanine (or a closely allied substance) is closely related to, or actually is the substance acted on by dopa-oxydase to form dopa-melanin, an insoluble pigment. The dioxypyphenylalanine employed was either a levorotatory or racemic (synthetic) form and little difference was noted in these experiments except perhaps in the very light reactions it was noted that the levorotatory form gave a stronger reaction.

Fate of melanin.—The fate of melanin in the body has been variously described. Some claim that the pigment enters the blood and is excreted by the glomeruli of the kidney as pigment granules. Others maintain that melanin is changed to colorless melanogen by the liver and then is excreted by the kidney.<sup>26</sup> Nepvin (quoted by Acton), claims that in malignant melanomas mela-

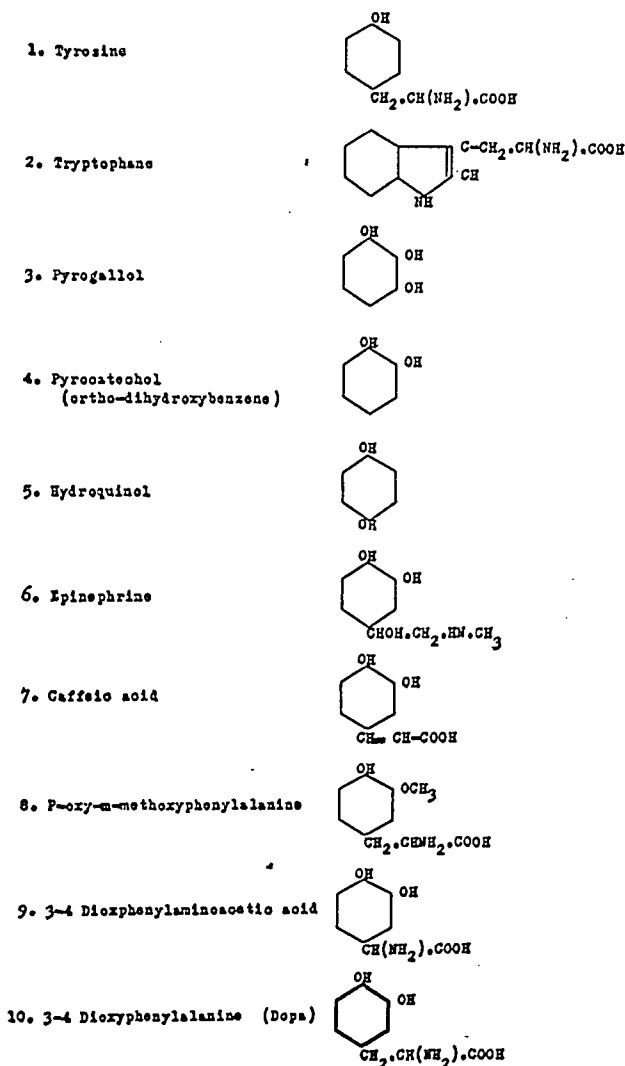


FIG. 1.—Chemical formula.

nin is found in the leucocytes in the blood producing melanemia, due to the great number of leucocytes carrying melanin. Acton believes that the achromatic melanogen excreted by the kidney is a reduction substance and not the mother substance of melanin.

Distribution of melanin.—Normally melanin is present mainly in the skin, eye and parts exposed to light.<sup>14</sup> It is also present to some extent in the central nervous system. In the skin it is found in the deeper layers of the rete malpighii and in the branching cells of the corium in the transition zone between the dermis and epidermis, and about the blood-vessels. In the dark races almost all the cells of the basal layer of the rete malpighii are pigmented but in the white races only the areola and mucocutaneous layer of the anogenital region are pigmented.<sup>14</sup> However, that the basal cells of the skin of the white races are potential melanin formers can be easily proved by the bronzing on exposure to the sun.<sup>22</sup> The fetus of both white and colored races have pigment in the basal cells of the rete malpighii, but the cells are depigmented in the white races. In the eye it is present in the cells of the choroid, iris, and ciliary process as phagocytosed pigment, and in the retina where it is a product of a neuro-epithelial cell.<sup>14, 20</sup> The other sites where melanin is present are the brain, cord and occasionally the internal organs. These are due to migration of melanin-producing cells along sympathetic nerves or vessels.

Function of melanin.—The function of melanin pigment is to protect against light, heat and moisture. In the animal it has the function of "adaptation, attraction and offensive and defensive mimicry."<sup>13</sup> Ewing quotes Eppinger who concludes that excess of pigment and its products, especially indol and skatol, are the cause of the overgrowth of cells. Artificial pigment or that extracted from tumors or urine are toxic for animals. Adler believes that the toxic effect may be due to the transformation of melanin into melanic acid which is the toxic agent.

*Relation of Nonmelanotic Melano-epithelioma to Melano-epithelioma.*—The absence of pigment in the melanotic tumors has been explained by Acton according to his conception of the two-cell theory, as follows: those arising from the melanoblasts, melanosaarcoma type, naturally would have pigment while the malignant melano-endothelioma type arising from both angioblasts and melanoblasts would have both pigmented and nonpigmented areas. And since one or the other of the cells may predominate, there would be no pigment if only the angioblasts were present.

Hertzler and Gibson accept Ribbert's chromatophore theory. The melanotic tumors arise from chromatophores whose specific function is to form pigment. These cells, however, often lie dormant, are colorless and give rise to tumors which differ from melanotic tumors only in not containing pigment. They claim that the tumors which tend to ulcerate usually contain little pigment.

Ribbert explains the presence of pigmented and nonpigmented cells side by side in some tumors, as cells which have maturity and immaturity, respectively. The immature cells cannot produce pigment. The nonpigmented part of some tumors may be due, however, to depigmentation.

Thibaudeau and Schreiner in their study of twenty-seven cases of melanotic cancer

believe that there is no relation between the amount of pigment found in the tumor and the degree of malignancy.

Broders and MacCarty, in their review of seventy cases of melano-epithelioma, maintain that the nonmelanotic tumors belong to the same family as the melano-epitheliomas and differ only in the lack of pigment. They have the same cell appearance as the nonpigmented areas of melano-epitheliomas and it is reasonable to believe, these authors state, that if the cells of the nonmelanotic tumors were given the opportunity to differentiate far enough, they would produce melanin.

Broders<sup>3</sup> says that differentiation is a means that malignant tumors have "of putting on the brakes." Melanin production is a form of differentiation. Producing pigment is a function of certain epithelial cells and when the cells proliferate rapidly they follow Marchand and Adami's law,<sup>14</sup> that as a cell carries out its vegetative powers it sacrifices its functioning powers; and we would therefore expect the nonmelanotic melano-epitheliomas to be rapid in growth; and their cells to be more primitive in type.

Another factor that shows that nonmelanotic melano-epitheliomas belong to the same family as the melano-epitheliomas is the presence of melanuria, as reported by various observers in nonpigmented tumors.<sup>23, 25</sup> It must be assumed, therefore, that the chromogen is present but is not acted on by the oxidase either because the cell is too immature to have the oxidase, or if it does have oxidase, not enough opportunity is offered for the oxidase to act on the chromogen, owing to the rapidity of growth.

*Pathology.*—The tissues in forty-nine cases of nonmelanotic melano-epithelioma were studied microscopically. In certain cases it could be easily demonstrated that malignant changes began in the basal-cell layer of the rete malpighii, either in the papillary or the interpapillary portions of the epidermis. (Fig. 2.) The malignant cells, epithelioid in form, could be seen streaming from one portion of the epithelium into the cutis and then spread out in its upper part. However, in other cases the malignant cells were restricted to the cutis and the epithelial layer was intact. In still others malignant cells from the cutis could be seen invading the subepithelial part of the cutis and even breaking through into the epithelial layer. In only a few cases was lymphocytic infiltration present in the subepithelial layer of the cutis.

The arrangement of the malignant cells was varied. In some it assumed the picture of a fibrosarcoma. (Fig. 3.) The cells were elongated markedly and arranged in whorls. In others an alveolar arrangement was present. (Fig. 4.) In most cases, however, the malignant cells were in solid masses resembling a large or small round-cell sarcoma or massive carcinoma. Only occasionally were the cells arranged in columns or cords. In a few cases the papillary portion of the cutis could be seen invaded by epithelioid cells from the epidermis; and as these cells forced their way into the deeper layers of the cutis they assumed an alveolar arrangement in one area and resembled a fibrosarcoma in an adjacent area, while in still another area the cells appeared definitely carcinomatous. There was little or no intercellular stroma apparent as a rule. Melanin was absent, but blood pigment was present in one case in the form of large irregular patches of a bright sheen. In a few cases the cells were closely applied to young blood-vessels.

The forms of the individual cells were as varied as their arrangement, spin-

dle-formed, round and oval, or markedly elongated. In some they approached more nearly epithelial cells. The nuclei were large in proportion to the rest of the cell, vesicular and hyperchromatic. Some were "one-eyed" (Fig. 5) showing one darkly stained nucleolus but more often there were two or three nucleoli in a meshwork of chromatin. Some of the nuclei appeared stippled, and mitotic figures were more or less numerous. Occasionally vacuoles were

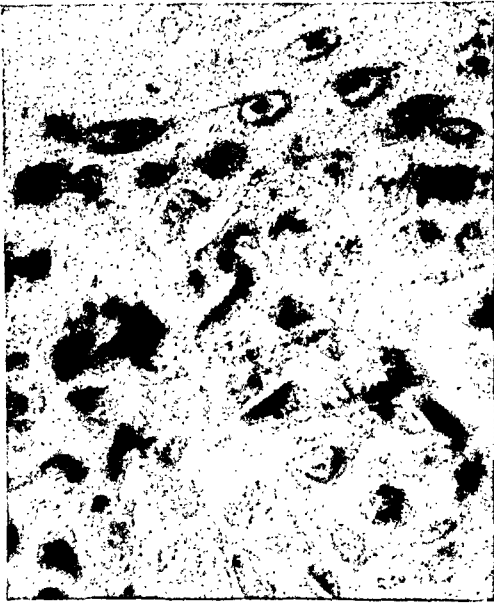


FIG. 2.—Nonmelanotic melano-epithelioma arising in the germinal layer of the skin. The cells are in direct continuity with the stratum germinativum.

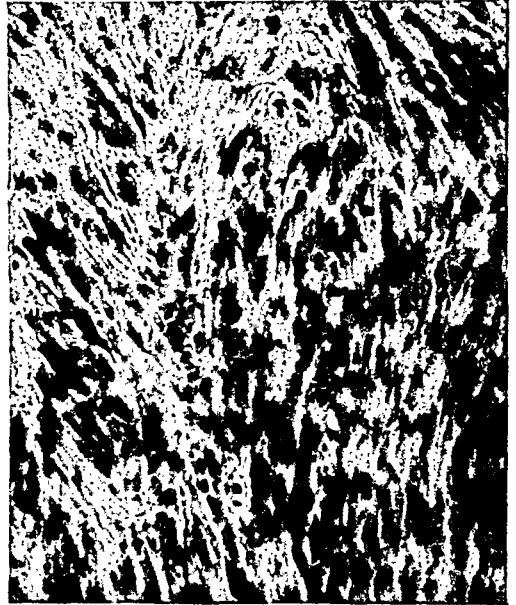


FIG. 3.—Elongated spindle cell simulating fibrosarcoma (x140).

seen in the nuclei. (Fig. 6.) A few sections were found replete with large giant cells with huge nuclei. According to Broders' gradation of epitheliomas all the tumors were graded 4, that is, there was little or no attempt at differentiation. The large cells apparently represent an embryonal state. In general every tumor studied gave the impression of a severe malignancy.

Whatever the form or arrangement of the cells, however, it was apparent that all the tumors were epithelial in origin. The variation in form was only evidence of a different stage of "dedifferentiation" or regression to a more embryonal state of development. This, with the absence of pigment, explains the highly malignant nature of the nonmelanotic melano-epitheliomas.

*Clinical Considerations.*—Malignant melanotic tumors were first described as occurring in horses in the latter part of the eighteenth century. Laennec first wrote about it in man. The nonmelanotic character of some of the tumors or nonpigmented areas in pigment tumors has been mentioned by many, but reports of cases that were nonmelanotic are few.

It is well known that the primary melanotic tumors may be pigmented and the secondary tumors nonpigmented or only partially pigmented. The reverse is also true.

*Etiology.*—The primary cause of melanotic tumors is as much a mystery as is the cause of other malignant tumors. Of the predisposing causes many

## MELANOTIC TUMORS

factors must be considered, namely, trauma, presence of a mole, wart or nevus, site of mole, age, and race.

The history of trauma is in many cases unreliable, but in some cases it is too definite to be ignored, especially when trauma is considered in its broader sense, including in its meaning such factors as chronic irritation, ill-advised and improper surgical procedures or the use of escharotics. In the cases reviewed

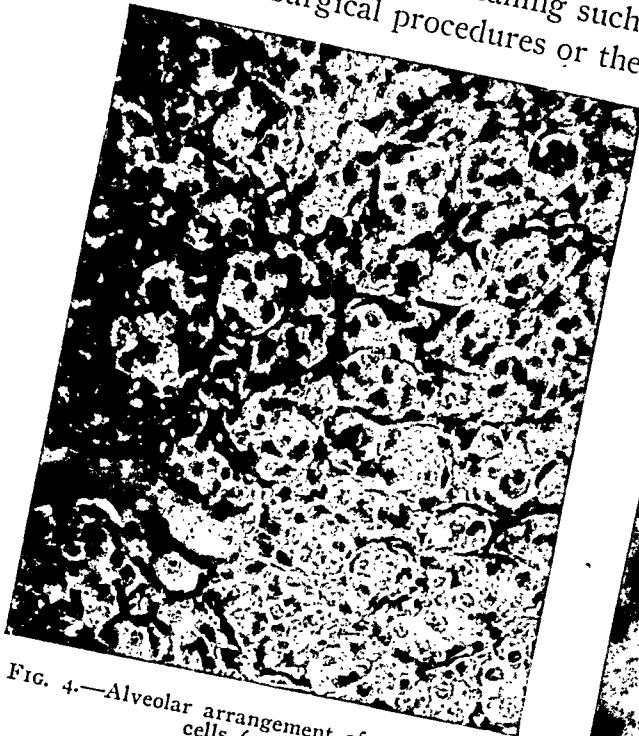


Fig. 4.—Alveolar arrangement of some of the cells (x140).

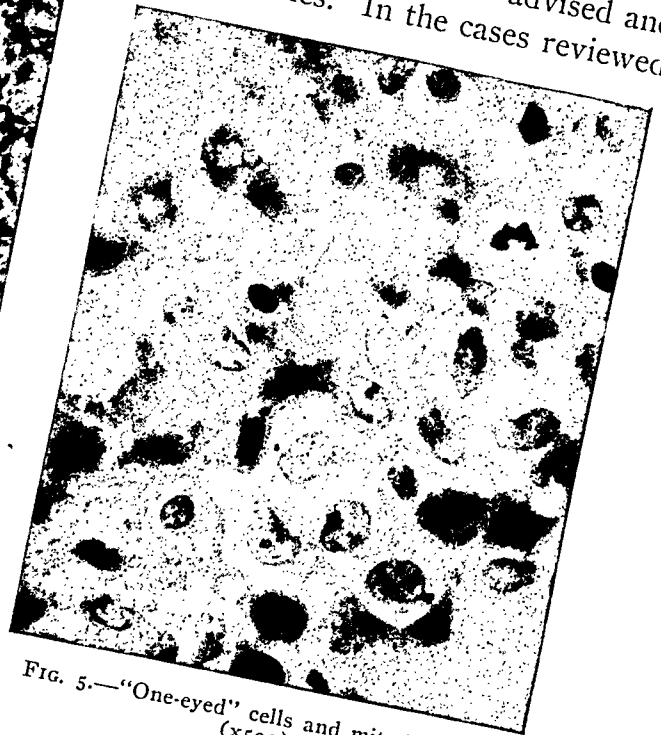


Fig. 5.—"One-eyed" cells and mitotic figures (x500).

here irritation was caused in many instances by improper shoes and in some the activity of the tumor was definitely accelerated after the use of escharotics, ligation, carbon-dioxide snow, and ill-advised operations. Activity seemed to begin in twenty-eight of the forty-nine cases (57.1 per cent.) following injury, irritation, or some means used for the removal of a mole or wart.

Heredity is probably not a factor. Pfingst and Graves report a case of melanosis of the eye in two brothers. They thought it to be coincidental. Incidence of carcinoma in the family was found in only six of our cases, but this figure is probably too low. The tumors may occur at any age, but usually past middle life. In this series of forty-nine cases the average age was fifty and three-tenths years, the youngest patient being twenty years and the oldest seventy-seven.

Years  
20-29  
30-39  
40-49

AGE BY DECADES  
Patients  
5  
7  
Years  
50-59  
60-69  
70-79

Patients  
12  
16  
2  
—  
49

Twenty-seven of the patients were males and twenty-two were females.

The dark races seem to be immune to this type of tumor. It is well known among veterinarians that gray horses after the age of ten become white due to loss of pigmentation in the hair, and then they are prone to melanotic carcinoma. Lubarsch quotes Folger's statistics of 527 carcinomas in 175,745 horses, 226 (42.88 per cent.) were melanotic in type. Of 2274 malignant tumors in 18,113 cadavers of human beings, twenty (0.89 per cent.) were melanotic.

Although it is true that the dark races are less prone to malignancy in general, still it is worthy of note that the melanotic tumors are almost unheard of in the dark races in spite of the fact that melanomas are more common in them than in the white races.<sup>32</sup> Seligman noted among the natives of New Guinea that pigmented moles were common on all parts of the body but none had been seen to spread or give to tumor formation. Gilchrist,<sup>32</sup> Sutton and Mallia and Stevenson, Hazen, Carmichael, and Menage describe malignant melanoma in negroes. In my series all patients were white.

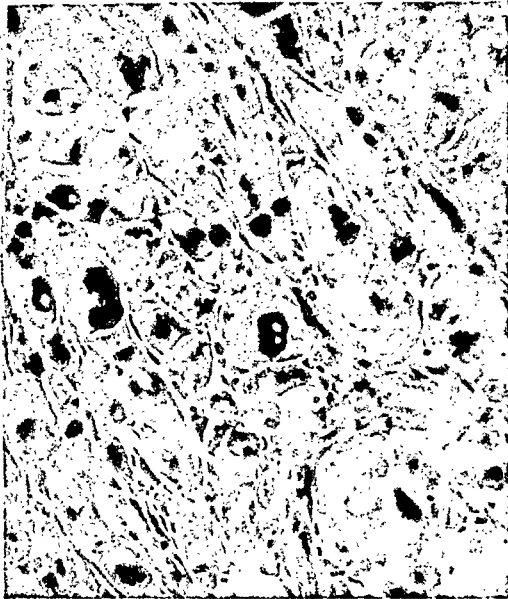


FIG. 6.—Enormous type of cell with large nuclei, some of which are vacuolated (x140).

In eighteen (36.7 per cent.) of the forty-nine cases of nonmelanotic melano-epithelioma the patients gave a history of the presence of a mole, wart, or nevus. In ninety-one cases of melanotic tumors reported by Coley and Hogue there was a history of mole in thirty-six (39.6 per cent.). In 33 per cent. of Dawson's cases there was a history of mole. In Broders and MacCarty's series of seventy cases, a history of mole, wart or nevus was given thirty-five times (50 per cent.). Apparently the presence of a mole does not indicate whether or not the resulting tumor will be pigmented.

#### SITE OF THE PRIMARY TUMOR

Site	Cases	Site	Cases
Foot (including ankle) .....	17	Nose .....	1
Leg .....	7	Eye .....	1
Thigh .....	2	Ear .....	1
Groin .....	2	Cheek .....	4
Thumb .....	2	Neck .....	2
Arm .....	1	Chest .....	2
Axilla .....	3	Back .....	2
Forehead .....	1	Vagina .....	1

—  
49

## MELANOTIC TUMORS

It will be noted that of the twenty-eight cases (57.1 per cent.) in which the lesion was on the lower extremities, it was on the foot (the part covered by the shoe) in seventeen (34.7 per cent.). (Fig. 7.) In Coley and Hoguet's series of ninety-one cases the pigmented tumors were on the lower extremities (from groin to toes) in thirty (33 per cent.), and in seventeen (18.7 per cent.) of these, on the foot and ankle; irritation was noted in sixteen of these seventeen cases. In Broders and MacCarty's series of seventy cases of melano-epithelioma, the lesions were on the lower extremities in twenty-nine (41.4 per cent.), and of these, sixteen (22.8 per cent.) were on the foot and ankle. In Dawson's series of thirty-six cases of moles showing transition to malignancy, ten (27.7 per cent.) occurred on the lower extremities and seven (19.4 per cent.) were on the foot. In thirty-one cases in which there was metastasis, Dawson reported nine (29 per cent.) on the lower extremities and of these six (19.4 per cent.) were on the foot. Hertzler and Gibson state that amelanotic types on arm or scalp have not been established. In the series reported here one occurred on the arm of a woman, aged twenty-nine, with metastasis to the axilla. A mole had been present since birth. In one case there was a history of chronic ulcer on the temple.

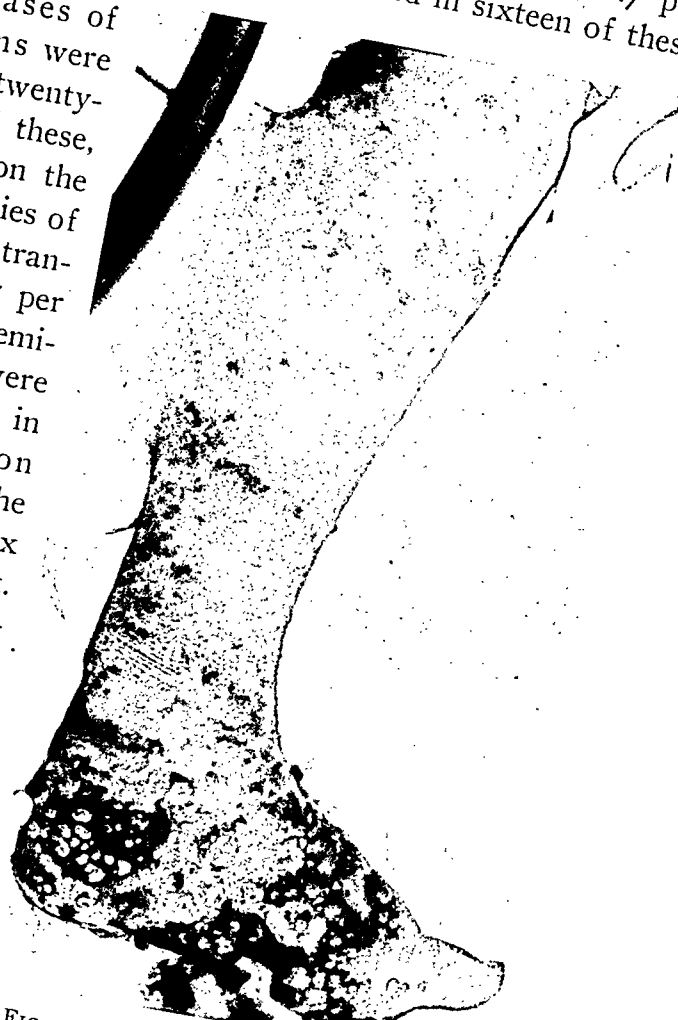


FIG. 7.—Nonmelanotic melano-epithelioma arising from an irritated spot on the heel, showing metastasis to skin of foot and leg.

*Symptoms.*—The symptoms in these cases are varied. There is usually a history of a mole or wart which may have been noticed since birth or for many years. This was either bruised, injured or irritated for a long time, especially if occurring on the foot. As was formerly stated, the history of injury is open to question in some of these cases, but on the other hand, in many others the history is too frank to be ignored. A discharging sore or bluish discoloration may follow an injury, or the mole or wart may gradually increase in size and then break down. The discharging sore may heal only to break down again in a short time. It is usually at this time that medical aid is sought and more often than not the true condition is unsuspected by both physician and patient. The area is either excised, or other means of removal such as curettement, ligation, carbon-dioxide snow or escharotics may have been used. This usually is quickly

followed by early recurrence locally and the activity of the tumor is manifested by rapid dissemination to the neighboring lymphatics. It is the multiple recurrences or the involvement of the regional nodes that makes the physician suspect the true significance of the previous symptoms. If the primary trouble occurs in the lymph-nodes the picture is still more confusing, and many times the axillary or inguinal swellings are incised because they are mistaken for abscesses. It is only occasionally that a patient in apparently good physical condition presents himself with generalized metastasis but is worried about the numerous little lumps over the body. Not infrequently there is a latent period between the appearance of the primary lesion and the metastasis. This latent period may be so long as to deceive the patient as to the real relation between the two, and it is only after close questioning that the physician discovers the primary cause, which the patient is only too prone to forget, or considers too trivial to mention.

The latent period may be as long as five or six years; in some instances the history dated back even longer, but this was open to doubt. The following is an example of a case in which there was a latent period of about three years and a rather rapid dissemination in about nine months. A married woman, aged forty-six, came to the Mayo Clinic in 1924 with definite symptoms of mild hyperthyroidism from adenomatous goitre. A thorough general examination did not disclose anything besides the adenomatous goitre and the usual features of hyperthyroidism. Following double resection of the goitre the pathologist's report corroborated the clinical diagnosis of hyperthyroidism. At that time there were no enlarged lymph-nodes, and the pelvic examinations were negative. In February, 1925, nine months later, the patient returned to the clinic complaining of many small lumps over the body of about nine months' duration. She said she had never felt so well in her life; the hyperthyroid symptoms had apparently completely disappeared. On general examination, the skin over the chest and back was peppered with hard firm nodules of various sizes. The right inguinal nodes were markedly enlarged and slightly tender. The pelvic examination disclosed two large immovable masses of firm consistence. After close questioning about the removal of moles and warts, the patient recollected that a small mole had been removed surgically from the anterior surface of the right leg, more than three years before. A healed scar without any sign of local recurrence was found over the anterior surface of the tibia. Pathologic examination of a nodule removed for diagnosis showed nonmelanotic melano-epithelioma. The patient died in November, 1925.

Thirty-five of the forty-nine patients in this series had been operated on or treated by some method for the purpose of removing the growth, previous to their coming to the clinic. The average duration of the lesion was approximately one year and four months. In twenty-two of the cases the lesion was either ulcerating or fungating and in some sinuses at the site of the lesion were discharging. Occasionally the lesion was described as bluish or, at times, brownish. Tenderness, inflammation and pain were not out-



## MELANOTIC TUMORS

standing features, and were only present, apparently, as a sequel to infection following ill-advised treatment.

In forty-nine cases, twenty-seven (55.1 per cent.) showed regional lymph-node metastasis, while seven (14.3 per cent.) showed generalized metastasis. In four there was only local recurrence.

*Diagnosis.*—The absolute diagnosis of nonmelanotic melano-epithelioma

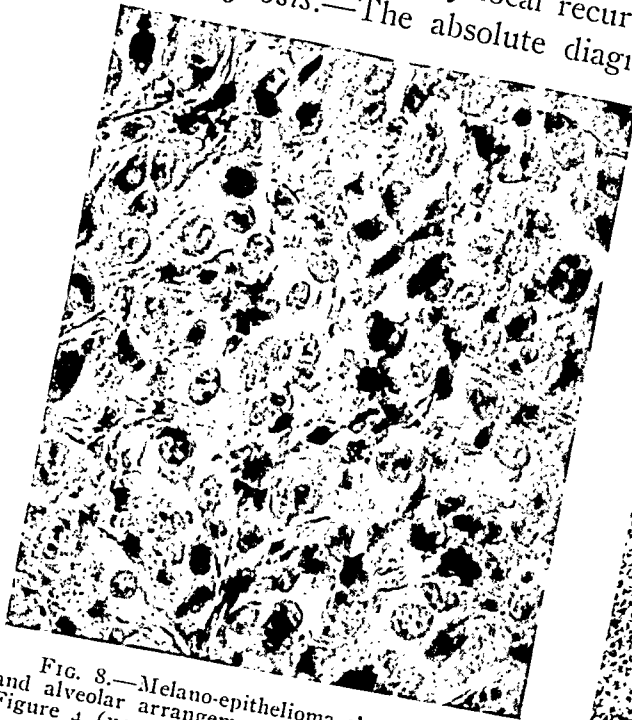


FIG. 8.—Melano-epithelioma showing melanin and alveolar arrangement of cells. Compare to Figure 4 (x200).

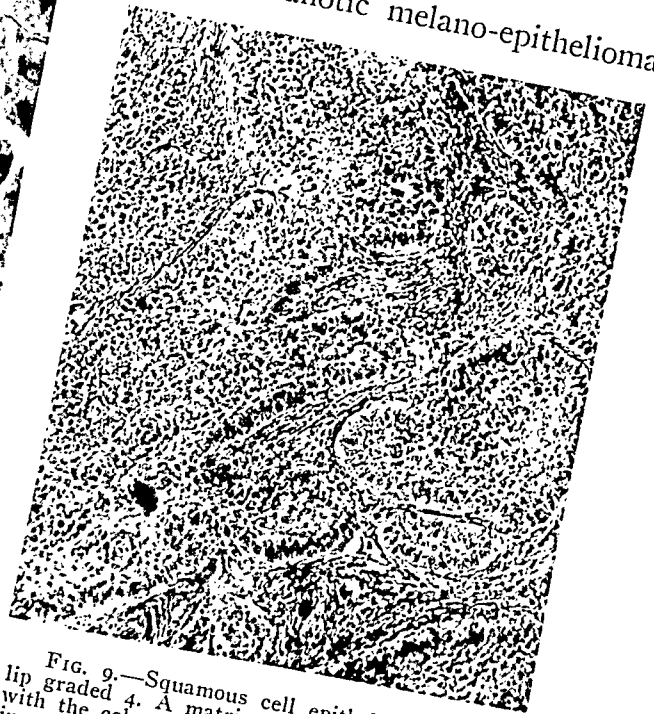


FIG. 9.—Squamous cell epithelioma of lower lip graded 4. A matrix and finger-like processes with the columnar cell formation in the advancing portions.

is only possible after microscopic examination. However, in a case of rapidly-growing tumor in which there was a history of a mole, usually on the lower extremities, and especially on the foot, which has been interfered with, or has been subjected to ill-advised treatment, the possibility of a melanotic epithelioma should be considered. If the tumor is very rapid in growth, and possibly if it is ulcerated or fungating in character, is prone to local recurrence or shows early regional lymph-node involvement, it is probably of the nonmelanotic variety.

The microscopic diagnosis of nonmelanotic melano-epithelioma is not simple. The cells may assume so many different forms and the mode of growth may be so varied as to tax the ability of the most competent pathologist. It is not at all unusual for nonmelanotic tumors to be diagnosed as small or large round-cell sarcoma, spindle-cell sarcoma, fibrosarcoma, myxomatous carcinoma or endothelioma. (Figs. 8 and 9.) Still the very fact that the cells are of such diverse shape and form, the mode of growth so varied, the individual cells so completely undifferentiated, and mitosis so frequently encountered, should be sufficient to remind one of the possibility of a nonmelanotic growth. If this diversified picture is found in adjacent areas of the same section, and especially if some definite connection is found with the epidermis, the diagnosis should be quite clear. Occasionally such a tumor may be pigmented due

to the extravasation of blood into the tumor and thus be mistaken for melanotic tumor. But the blood pigment usually has a brighter sheen, is distributed in clumps and irregular patches, and lacks the fine diffuse and regular distribution of melanin pigment.

*Prognosis.*—The prognosis at the very best is poor. All the tumors of the nonmelanotic variety in our series were graded 4 or 4+, according to Broders' classification. This would mean a good result in only 10 per cent. of the cases. But since in the recent revision of the term, grade 4 malignancy, Broders<sup>4</sup> has stated that it should signify from 75 to 100 per cent. undifferentiated cells and 0 per cent. to 25 per cent. differentiated cells, and since the nonmelanotic tumors are usually almost 100 per cent. undifferentiated, it is only reasonable to expect the results to be very unfavorable.

Forty-four of the forty-nine patients were traced. Thirty-nine (88.6 per cent.) were dead. Most of the patients not traced are no doubt dead because in several generalized metastasis was present when they were last examined. (Tabulation.)

TABULATION  
RESULTS OF TREATMENT OF NONMELANOTIC MELANO-EPITHELIOMA

	Cases		Deaths		Patients living	Average post-operative therapeutic life (approximately)†	Range of post-operative therapeutic life (approximately)
	Total	Traced	Number	Per cent.			
Surgery only...	14	11	10	90.9	1 (7 months later)	18.8 months	2 weeks to 6.5 years
Radium or Röntgen-rays only*	5	5	4	80.0	1 (7 months later)	16.8 months	7 to 25 months
Surgery and radium or Röntgen-rays	9	8	5	62.5	3 (2 years 11 months 3 years 8 months 5 years 9 months)	6.1 months	4.5 to 9 months

\* Excluding diagnostic biopsy.

† Date of death was not given in three cases in which surgery only was employed and in one in which there was surgery and radium or Röntgen-rays.

*Treatment.*—With the foregoing prognosis the treatment is far from satisfactory. The use of radium and Röntgen-rays is condemned by some and advocated by others. Wood advises against it in those cases amenable to surgery and Hertzler believes that radium and Röntgen-rays are absolutely contraindicated and worse than useless. Hutchins argues for the removal of moles by electrolysis, caustics or "high potential" treatments because of the good cosmetic result, lack of bleeding and less danger of infection. Owen, and Montgomery and Culver describe a case of melanotic tumor successfully treated by radium.

Thibaudeau and Schreiner report clinical cure in 50 per cent. of melanotic tumors before metastasis appeared and in half of these (25 per cent.) a clinical cure was obtained for two and a half years or more. One case in which the patient was still well after seven years was reported. In another inoperable case in which the tumor was situated at the inner canthus of the eye, the patient was reported to be well after two and a half years following filtered high-voltage Röntgen-ray treatment.

# THE DE PETZ STOMACH AND INTESTINAL SUTURING APPARATUS

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THE success of operations carried out within the sphere of the digestive tube depends chiefly on whether we are able to maintain and secure aseptic conditions during our operation.

Although complete asepsis in the most restricted sense of the term is naturally impossible in operations of this character, we nevertheless can achieve relative asepsis by reducing the operating time as much as possible so as to minimize the possibility of infection and by trying to keep all bacteria, and particularly those of the stomach and intestines, away from the abdominal cavity.

Careful isolation of the area of operation, precise closing of stomach and intestinal wounds, and rapid and clean working are gener-

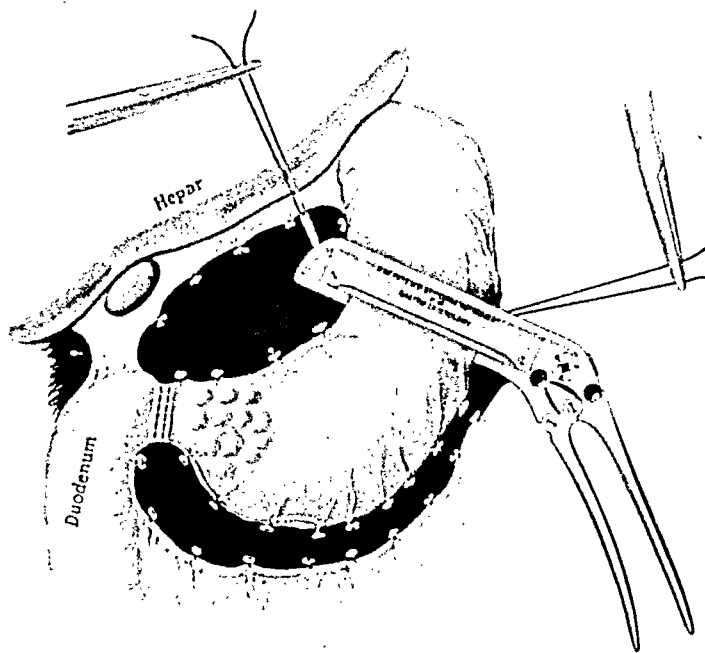


FIG. 1.—Resection of the stomach. First stage of Billroth II, retrocolica posterior.

ally known and adopted measures while the details of the operating technic leave much to be desired.

The importance of the latter is best illustrated by the various and never ending experiments by means of which surgeons hope to solve the most difficult technical problems.

All sorts of instruments have already been designed to eliminate infection such as the stomach and intestinal clamps of Payr, Graser, etc., and various types of sewing apparatus including the one brought out by Hüttl-Fischer which was probably the most serviceable and very likely the one most in use.

However, a great disadvantage of the Hüttl-Fischer sewing apparatus is its high price, an item of special importance under existing economic conditions.

## MELANOTIC TUMORS

Coley and Hoguet, in their study of ninety-one cases of melanotic tumor, used Coley's serum (mixed toxins of erysipelas and *Bacillus prodigiosus*) with marked retardation of growth of the tumor.

In my series, radium or Röntgen-ray treatment was advised in inoperable cases and many were also advised to use Coley's serum, but lately the serum has not been urged. Operation, in the form of wide excision by cautery, or amputation (if on a limb) with removal of the regional lymph-nodes, or irradiation of the regional lymphatics, was resorted to in cases amenable to treatment.

Desjardins<sup>12</sup> believes that the melanotic tumors are the most resistant variety of neoplasms but that occasionally certain cases do respond to radiotherapy. But in order to obtain any such response he maintains that treatment must be thorough. In some cases he has obtained encouraging and sometimes quite satisfactory results.

If a more favorable outlook is to be established stress must be placed on treatment which is anticipatory rather than remedial. "Cosmeticians" and beauty parlor "experts" have learned to give moles a wide berth. The mole has acquired the pseudonym of "touch-me-not" spot, from those who have had bitter experience with it. However, a mole which is constantly irritated, especially one on the lower extremities, and more especially one on the foot, should be removed by a wide excision, preferably by cautery, including the deep fascia and subcutaneous tissue. Any mole which is degenerating or showing evidence of beginning activity, such as bluish discoloration, or gradual increase in size, should be accorded the same treatment. And if unfortunately the mole shows beginning malignancy, then excision alone is not sufficient. The only safe treatment is complete removal of the glands of the nodes, as would be done in the case of a small nodule of carcinoma in the breast. New and Hansel do not believe that "removal of the glands of the neck in an attempt to block the growth from metastasizing is of value; nor is a block dissection of value when a gland of the neck is involved."

### CONCLUSIONS.

1. The nonmelanotic tumors belong to the same family as the melanotic tumors and differ only in the absence of pigment.
2. The absence of pigment in these tumors is evidence of their rapid growth, for melanin production is a form of differentiation.
3. Histologically it can be demonstrated that malignant changes begin in the basal-cell layer of the rete malpighii.
4. The arrangement and form of the individual cells are quite varied, and are evidence of a different stage of "dedifferentiation."
5. According to Broders' classification all of the forty-nine cases of non-melanotic melano-epithelioma occurring in the Mayo Clinic are of the grade 4 type.
6. A clinical review of these cases shows that they usually occur when the patient is past middle life. More than half of the growths are on the lower

extremities, especially on the foot, and in more than a third there is a history of a mole, nevus or wart.

7. The prognosis, as would be expected from any malignant growth graded 4, is very poor.

8. Prophylactic excision of moles, especially those occurring on the lower extremities, and wide excision by cautery, with eradication of regional lymph-nodes in moles showing malignant change, is advocated. Radium and Röntgen-rays should be used as an adjunct to surgery and in those cases not amenable to surgery.

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# MALIGNANT LYMPHOCYTOMA

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THE purpose of this paper is to report two unusual cases of malignant lymphocytoma, and at the same time to plead for greater uniformity in the nomenclature of lymphoid tumors.

The first case is one of malignant lymphocytoma primary in the small intestine, a condition of sufficiently rare occurrence to warrant its being placed on record. Only one other such case has occurred in the Montreal General Hospital during the past fifteen years.

The second case is one of malignant lymphocytoma of the cervical lymph glands, with an extradural spinal metastasis occurring nine years after the first appearance of a tumor in the neck. The extreme rarity of spinal metastases of lymphoid tumors, and the long duration of this disease in this case, are two features of unusual interest.

Tumors of lymphoid tissue include simple inflammatory hyperplasias, rapidly growing neoplasms, and a variety of intermediate types.

Inflammatory hyperplasias are of frequent occurrence, and are the physiological response to an irritant, bacterial or toxic, brought to the tissue by afferent lymph or blood-vessels.

Neoplastic tumors are the result of an overgrowth of atypical lymphoid cells. They are of relatively uncommon occurrence and their etiology is obscure.

Also of unknown etiology are such conditions as lymph-adenoma, leukaemia, and pseudoleukaemia, which produce a more or less diffuse enlargement of lymphoid tissues and may for this reason lead to difficulties in differential diagnosis.

It is unfortunate that there is such a lack of uniformity in the nomenclature of lymphoid tumors, but this may be partly explained by the lack of knowledge as to their etiology. Since an etiological classification is rendered impossible, the most satisfactory one is based on histogenesis and structure.

The following is the classification of Ewing<sup>1</sup>: There are three elements in lymphoid tissue capable of giving rise to lymphoid tumors, namely: (1) lymphocytes, (2) reticulum cells of follicles and pulp, (3) endothelial cells of pulp and cavernous sinuses. According to histogenesis, tumors of lymphoid tissues are classified as follows:

(1) Lymphocytes	Lymphocytoma	<ul style="list-style-type: none"> <li>Simple lymphoma</li> <li>Tuberculous lymphoma</li> <li>Lymphatic leukæmia</li> <li>Pseudoleukæmia</li> <li>Malignant lymphocytoma (lymphosarcoma)</li> </ul>
(2) Reticulum cells	Large round-cell hyperplasia or neoplasia	<ul style="list-style-type: none"> <li>Granuloma malignum</li> <li>Myeloid leukæmia</li> <li>Hodgkin's sarcoma</li> <li>Large-cell sarcoma (lymphosarcoma)</li> </ul>
(3) Endothelial cells	Endothelial hyperplasia or neoplasia	<ul style="list-style-type: none"> <li>Endothelial hyperplasia of tuberculosis, etc.</li> <li>Endothelioma</li> </ul>

The description of two cases of slowly growing lymphosarcoma constitutes the basis of this paper, and further discussion will be limited to this type of tumor.

Lymphosarcoma arises in situations where lymphoid tissue abounds. It is a malignant neoplasm which is locally destructive and which tends to extend by permeation of lymphatics. It arises from an overgrowth of atypical lymphoid cells and may be of two types, a malignant lymphocytoma arising from lymphocytes, or a large-cell sarcoma arising from reticulum cells.

Structurally, lymphosarcomata are characterized by a diffuse overgrowth of lymphoid cells enmeshed in a fine reticulum. The structure varies somewhat according to the rapidity of the growth of the tumor. In rapidly growing tumors there is very little reticulum, the nuclei of the tumor cells are compact and hyperchromatic, and many mitotic figures are seen. In more slowly growing types, the reticulum may be thickened in some areas, even with a tendency to fibrosis, while the nuclei are more vesicular, less pyknotic, and show fewer mitotic figures.

CASE I.—Hospital record M. G. H. No. 2070-1927. H. G., male, age fifty years, was admitted into the Medical Service at the Montreal General Hospital on April 13, 1927.

*Complaints.*—1. Pain in the epigastrium. 2. Vomiting. 3. Loss of weight and strength.

*Personal History.*—He had been born in England but had lived in Canada since 1904. He was a stationary fireman; was unmarried; smoked heavily; drank moderately; and had had no serious illnesses apart from a Pott's fracture of the left ankle, and a fracture of the olecranon process of the right ulna.

*Family History.*—Irrelevant.

*Present Illness.*—In January, 1927, diarrhœa developed and became rapidly worse until the patient was passing twenty fluid stools daily. He stated that he had never noticed any blood in the stools but that on one occasion he observed a piece of tissue three inches in diameter which contained small "veins." There was nausea and vomiting, occurring daily about one-half hour after the midday meal. He stopped work and was given a remedy which checked the diarrhœa and vomiting. Shortly before admission, severe cramp-like pain developed in the epigastrium after eating, lasting for a few minutes. More recently the pain had become more frequent.



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occurring at irregular intervals and bearing no relation to the taking of food. The pain was always situated in the epigastrium and, for five days before operation, was so severe as to require the administration of morphia each night.

The appetite had remained good, but the patient was afraid to eat for fear of provoking pain. He lost fifty pounds in weight during the three months prior to admission. There was a corresponding loss of strength.

*Condition on Admission.*—The patient was emaciated. The temperature was normal; the pulse was regular, rate 72; and the respiratory and cardiovascular systems were negative. There was no generalized glandular enlargement. The abdomen was scaphoid. The recti muscles were tense in the upper half of the abdomen. Tenderness was present immediately above the umbilicus. No organs or masses were palpable. The abdomen was tympanitic throughout.

*Laboratory Tests.*—Urine—negative. Stools—no visible or occult blood. Blood examination—3,500,000 erythrocytes, 7150 leucocytes, 80 per cent. hæmoglobin.

X-ray examination of the gastro-intestinal tract following the administration of a barium meal, showed in the six-hour plate (Fig. 1) a marked distention of the small bowel, and a "step-ladder" arrangement of the coils of the ileum due to a partial obstruction.

The diagnosis of a partial obstruction of the small bowel was made, and the patient was transferred to the Surgical Service of Dr. E. M. Eberts.

April 26, 1927, the abdomen was opened under ether anaesthesia. From a point six inches above the ileocaecal valve, and extending proximally for a distance of two feet, the ileum was found to be of a purplish color. Its walls were greatly thickened, rigid, and in places covered with a greenish-yellow, translucent, gelatinous exudate. There were numerous enlarged lymph glands in the mesentery. The involved portion of the ileum, together with its mesentery, was resected, and an end to end anastomosis performed.

The patient had an uneventful recovery. He received one X-ray treatment before leaving hospital on May 27, 1927. Six months later he was enjoying perfect health; had gained fifty-three pounds in weight, and there was no evidence of recurrence.

*Pathology.*—(M. G. H. S-27-423.) The specimen consists of a portion of ileum seventy centimetres in length, together with its mesentery. (Fig. 2.) The walls are thickened and oedematous. The mucosa presents a pebbled appearance and there are multiple minute areas of superficial ulceration. Along the line of mesenteric attachment



FIG. 1.—Barium series, six-hour plate, showing distention of small bowel and a step-ladder effect in the arrangement of the coils of the ileum.

# MALIGNANT LYMPHOCYTOMA

of the intestine there are numerous yellowish, firm, oval lymph-nodes, varying from one-half to one centimetre in diameter. Transverse section of the bowel shows macroscopically, marked infiltration of the muscularis with grayish-yellow tissue. In the root of the mesentery there are a number of large, firm, discrete lymph-nodes, which on section bulge from their capsules.

## *Histological Structure.*—

The intestinal mucous membrane is normal except for areas of superficial ulceration which occur between low papillae projecting into the intestinal lumen. (Fig. 3.) These projections are the result of local aggregations of tumor cells in the submucosa, and they give to the mucosa its pebbled appearance.

The submucosa is largely replaced by tumor tissue

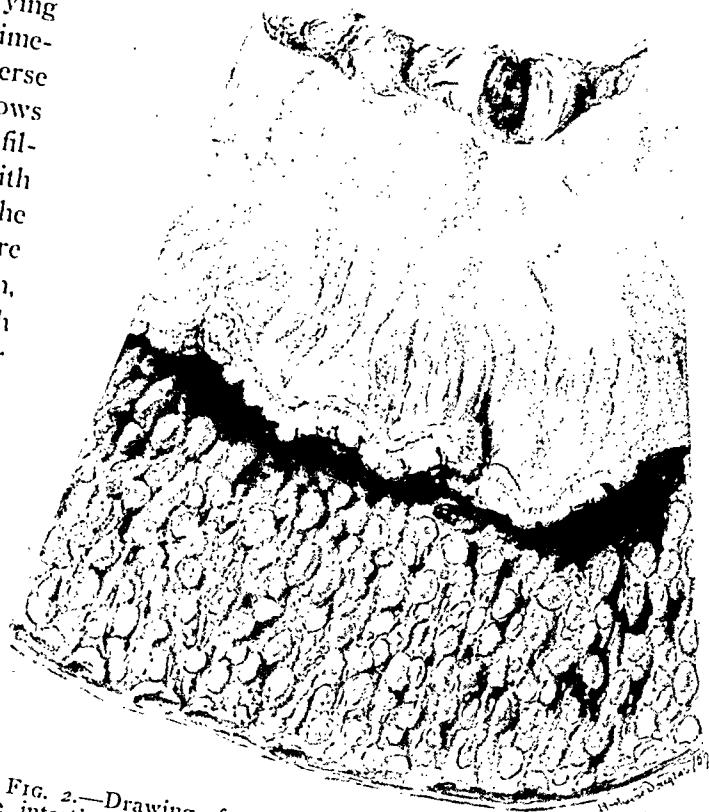


FIG. 2.—Drawing of a portion of the ileum with its mesentery. The intestine has been laid open. Its walls are thickened, and the mucosa has a pebbled appearance due to the presence of multiple small tumors of the submucosa. The mesentery contains many firm, discrete, enlarged lymph-nodes.

which is not of a uniform structure. In some areas there are nests and cords of tumor cells with little or no stroma, while in other areas there is a dense fibrous tissue in which there are few tumor cells. From the submucosa, columns of tumor cells are seen invading the muscular coats, producing a wide separation between the muscle bundles. (Fig. 4.)

The tumor invasion extends through the muscular coats into the fatty tissue of the mesentery, which is thickened by local and diffuse tumor cell aggregations, and by an increase of fibrous connective tissue. The structure of the mesenteric lymph-nodes is completely obliterated by invasion with tumor cells. The peritoneum is normal.

The tumor cells are

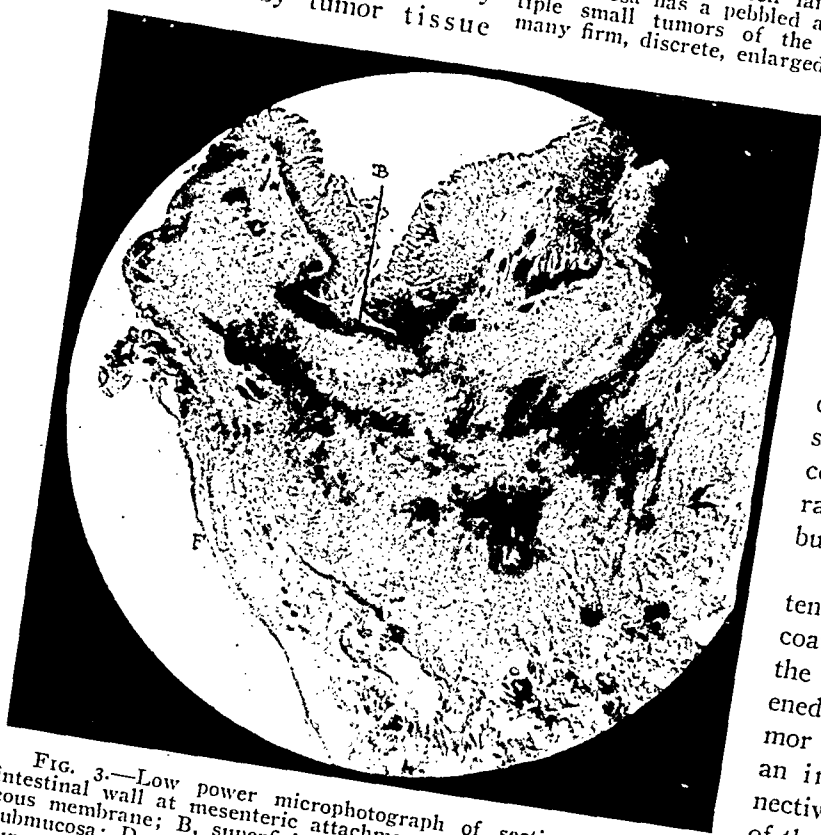


FIG. 3.—Low power microphotograph of section through the intestinal wall at mesenteric attachment showing: A, normal mucous membrane; B, superficial ulceration of mucosa; C, thickened submucosa; D, muscular coats of intestine; E, nests and cords of tumor cells extending from submucosa through the muscular coats and invading the fatty tissue of the mesentery; F, peritoneum.



FIG. 4.—Section through circular muscle coat of ileum showing separation of muscle bundles by columns of invading tumor cells.

*Diagnosis.*—Malignant lymphocytoma (lymphosarcoma).

*Discussion.*—Lymphosarcoma of the intestine is most frequent during the third and fourth decades of life. It is usually characterized by an insidious onset, but some cases have been reported of acute onset simulating appendicitis. Ochsner<sup>3</sup> describes the early symptoms as follows: "Indefinite abdominal pain which is persistent and not relieved by rest or starvation. The pain is not well localized, is colicky, and often associated with anemia and cachexia." Symptoms of partial obstruction are not uncommon, and acute obstruction occasionally occurs, due to an intussusception at the site of the tumor. A palpable mass is sometimes present within the abdomen, and, when present, greatly facilitates the diagnosis.

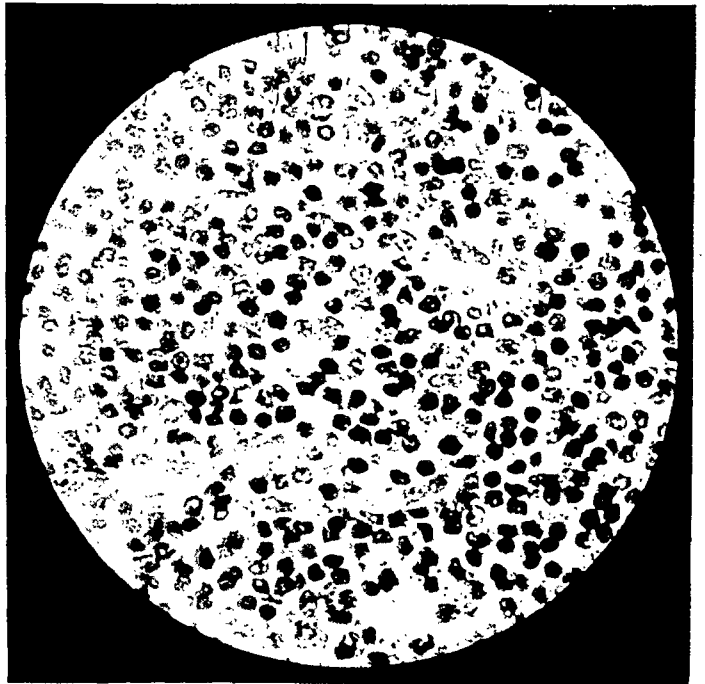


FIG. 5.—High power microphotograph of section from mesenteric lymph-node showing small round tumor cells and fibroblasts.

## MALIGNANT LYMPHOCYTOMA

Lymphosarcoma of the intestines most commonly affects the lower portion of the ileum. Beginning as a localized thickening of the submucosa, areas of ulceration of the mucosa not infrequently result. The tumor may extend through and destroy the muscular coats, and appear beneath the serosa. Metastases to the regional lymph-nodes occur early.

Aneurismal dilatation of the intestine is frequent, and Graves<sup>2</sup> has offered the explanation that this may be due either to an early destruction of the muscle fibres with subsequent dilatation resulting from an accumulation of faeces, or to the early involvement of the submucosa with effect on its plexus of nerves.

Stenosis of the bowel is less common. When it does occur, it is usually the result of fibrous tissue contraction which takes place late in the disease. With the progress of the disease, a large segment of the bowel may become involved, and partial obstruction occur as a result of the loss of peristalsis. A rare cause of stenosis is the presence of a polypoidal tumor mass protruding into the lumen of the intestine. Such a case was reported by De Noyelles.<sup>4</sup>

*Treatment.*—The method of treatment which gives promise of yielding the best results is the thorough excision

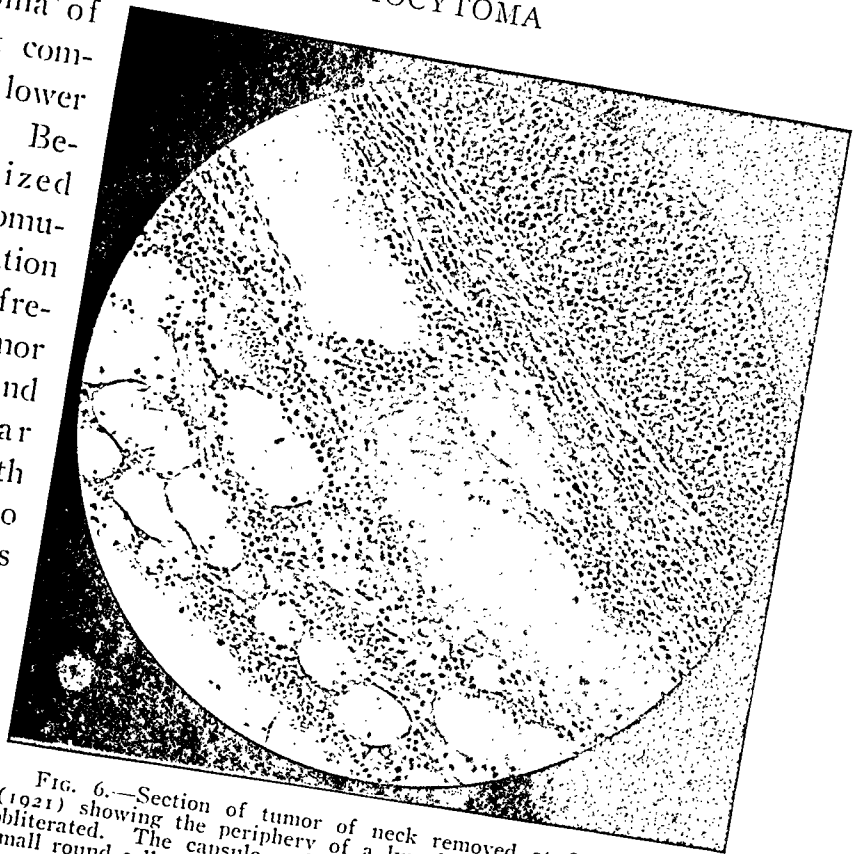


FIG. 6.—Section of tumor of neck removed at first operation (1921) showing the periphery of a lymph-node whose structure is obliterated. The capsule and surrounding tissues are invaded by small round cells of the lymphoid series.

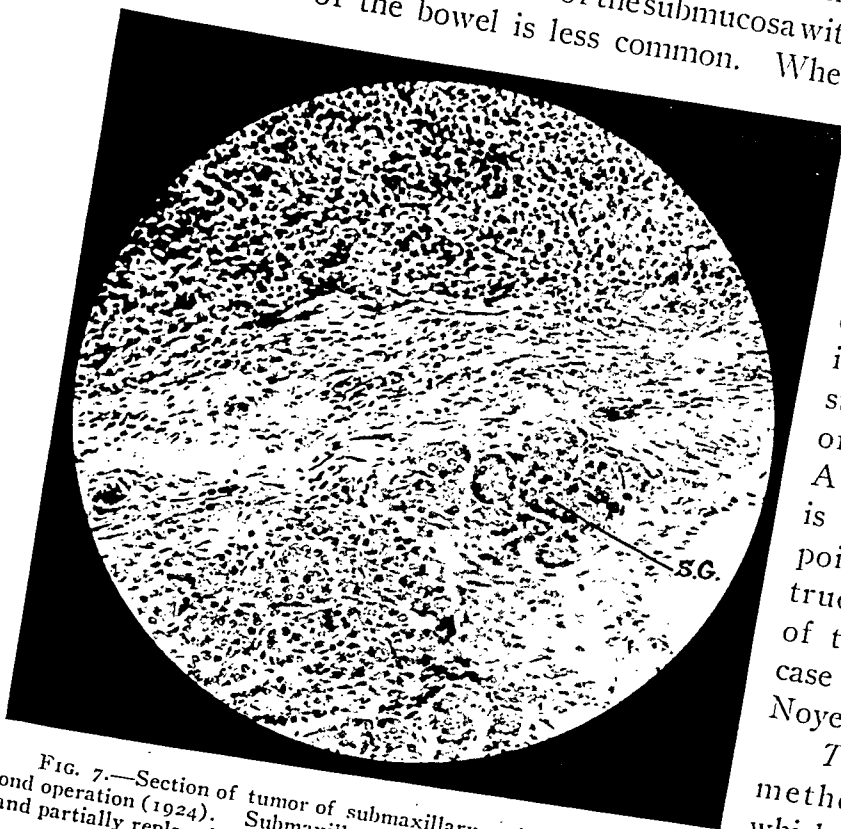


FIG. 7.—Section of tumor of submaxillary region removed at second operation (1924). Submaxillary salivary gland (S.G.) is invaded and partially replaced by tumor composed of small round cells.

of the tumor at the earliest possible date, following by irradiation. The value of radium in the treatment of lymphosarcoma is unquestioned. Bloodgood<sup>5</sup> states: "The one lesion of which, as far as I know, surgery has never accomplished a cure, is lymphosarcoma of the lymph glands, and apparently radium has done so." In an article on lymphoblastoma, Minot<sup>6</sup> says that "irradiation is of great value. It alleviates the symptoms, decreases the size of the lesions, and improves the patient's efficiency in spite of the fact that it does not appear to influence importantly the duration of the disease."

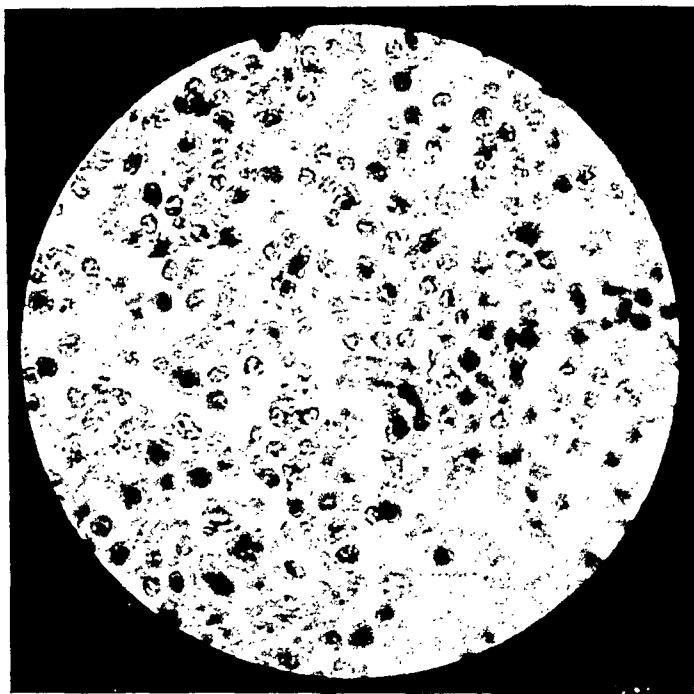


FIG. 8.—High power microphotograph of section from tumor of submaxillary region removed at second operation (1924), showing tumor cells and a small number of reticular cells.

*Personal History.*—He had always lived in Canada, and with the exception of frequent attacks of tonsillitis, his general health had been good. Married at the age of twenty-five, his wife had had no children and no miscarriages. There was no history of lues. He was employed as a railway shop foreman. He was a moderate smoker, and but seldom took alcoholic stimulants.

*Family History.*—Irrelevant.

*Present Illness.*—In 1918, a tumor appeared in front of the left ear, and one year later a similar swelling developed behind the angle of the jaw on the left side. Soon after this, masses were noticed behind the sternomastoid muscle on the left side of the neck. In 1920, surgical advice was sought, and examination showed the tumors to consist of enlarged lymph glands which were freely movable, discrete, moderately firm, and not tender. Their removal was advised, but not until 1921, three years after the onset of the disease, did the patient consent to operation. At operation, the glands were found to be slightly adherent to the neighboring tissues, firm, and of a yellowish-gray color on cut section. Following adenectomy, he received five X-ray treatments.

*Pathology.*—(M. G. H. S-21-578.) Microscopic examination shows a diffuse overgrowth of small round cells with pyknotic nuclei, producing complete obliteration of

*Prognosis.*—In untreated intestinal cases, the condition becomes rapidly fatal. Treatment offers no prospect of a permanent cure, but may prolong the patient's life for several months. Rare cases are reported of patients who have lived three years after operation.

CASE II.—Hospital record M. G. H., No. 4275-1927. G. H., male, age thirty-nine years, was admitted into the Surgical Service of Dr. E. M. Eberts at the Montreal General Hospital on August 9, 1927, complaining of weakness in the legs, and pain encircling the chest.

## STOMACH SUTURING APPARATUS

Therefore, we welcomed de Petz when he demonstrated his sewing apparatus on the occasion of the eighth annual meeting of the Hungarian Surgical Association in 1921, and recommended its use for the purposes of stomach and intestinal surgery. In vol. lxxxvi, No. 3, September, 1927, of the *ANNALS OF SURGERY*, de Petz explained his instrument and the operating technic connected therewith in detail, but as his instrument has not been hitherto universally adopted,\* I think it worth while to state here a summary of our two years of experience.

In literature I have found two references to the de Petz instrument, one dealing with successful operations by Klaus, of Tuttlingen, Germany, published in 1925 under the title "On the Technic of Stomach Resections" in No. 1 of the *Zentralblatt für Chirurgie* and reporting twelve cases of resection carried out by the author by means of the de Petz instrument, and the other reference having to do with Domenico Taddei, professor of surgery and director of the sur-

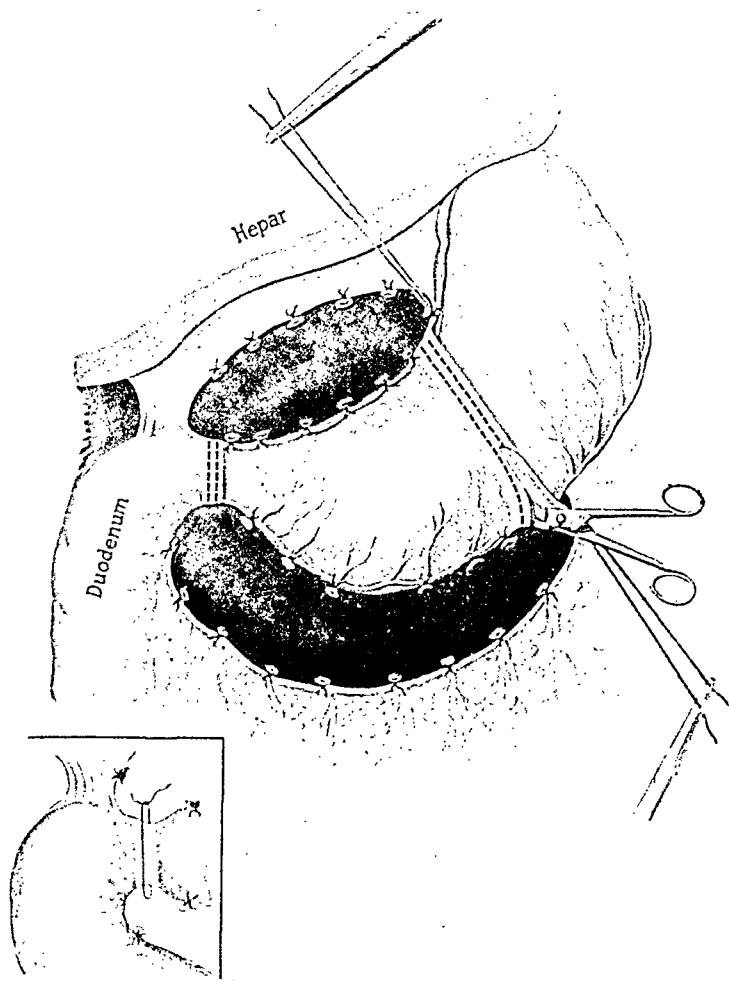


FIG. 2.—Resection of the stomach. Second stage of Billroth II, retrocolica posterior.

gical clinic of the Royal University of Pisa, Italy, who, at the 34th congress of the Italian Surgical Association held at Padova in October, 1926, reported about his favorable experiences with the de Petz stomach sewing apparatus, the subject matter of his report bearing the caption "Per La Tecnica Delle Sezioni Gastrointestinali," published in the *Annali Italiani di Chirurgia*, Fasc. 12, 1926.

In the surgical clinic of Debreczen we have carried out 92 stomach resections during the last two years, 58 cases being resected by means of the de Petz sewing apparatus and, for comparison's sake, 34 cases without it, and our observations were chiefly centred on whether and in how many

\*I am informed that about 100 of the de Petz sewing apparatus are at present in use in the principal countries of the globe. The Kny-Scheerer Company of New York are agents for it in the United States of America.

## MALIGNANT LYMPHOCYTOMA

the normal structure of the lymph glands. There is definite invasion of the capsule and of surrounding tissues. (Fig. 6.) Diagnosis: Lymphosarcoma.

In June, 1924, three years after the first operation, or six years after the onset of the disease, a mass appeared on the left side of the neck anterior to the sternomastoid muscle. Under local anaesthesia this was removed, and found to consist of several enlarged lymph glands similar in gross appearance to those previously removed. Microscopic examination (Fig. 7) reveals a compact tumor mass made up of small round cells with scanty stroma, invading the fixed tissues. In the tissue removed is a portion of submaxillary salivary gland which is diffusely invaded and partially replaced.

The characteristic tumor cell (Fig. 8) is small and round, with little cytoplasm. The nucleus is pale, but shows a sharply staining granular network and peripheral chromaffin ring. Intermingled with these cells are a small number of reticular cells. Diagnosis: Lymphosarcoma.



FIG. 9.—X-ray of spine following injection of lipiodol into the cisterna magna, showing obstruction of the spinal canal at the level of the second dorsal vertebra.

He was again given a course of five X-ray treatments, and enjoyed comparatively good health until December, 1926, two and a half years after the second operation, when a feeling of tightness and pain in the left side of the chest was complained of. Physical examination was negative. In June, 1927, the pain became localized to the left axilla and scapular region. Stereoscopic X-ray examination of the thorax eliminated the probability of a mediastinal tumor. The pain gradually increased in severity, became bilateral, and, at the beginning of August, 1927, was described as being situated in the thoracic vertebrae and radiating from there around the chest under the arms. During the week prior to admission (August 9, 1927), there had been rapid loss of power in the legs.

*Condition on Admission.*—The patient was well developed but had apparently lost considerable weight recently. The skin and mucous membranes showed a moderate degree of pallor. The temperature was normal; the pulse was regular, rate 84; and the respiratory, cardiovascular, and digestive systems were negative.

*Nervous System.*—Report of examination by Dr. F. H. Mackay, neurologist to the Montreal General Hospital, is as follows: "The cranial nerves are normal. The upper extremities are normal in movement and coördination, but the lower extremities show a marked muscular weakness and only slight movement of the feet and toes can be obtained. The sense of position and vibration is lost in the lower extremities. There

is marked hypoaesthesia and hypoaesthesia over the trunk and lower limbs from the level of the fourth thoracic segment.

Reflexes		
Knee jerks .....	++++	Right side
Ankle jerks .....	++	
Plantar .....	++	Left side
Abdominal .....	0	
Clonus .....	+	extension

"Lumbar Puncture.—Spinal pressure of 110 mm. of water, showing no alteration on jugular compression. The spinal fluid was of a slightly yellowish color, contained 345

cells per cubic mm., and gave a +++ globulin reaction. Diagnosis: A transverse lesion of the spinal cord from pressure."

X-ray.—(Fig. 9.) Following the injection of 1 c.c. of lipiodol into the cisterna magna, X-ray showed an obstruction at the level of the second dorsal vertebra (fourth dorsal segment). Spinal fluid Wassermann and colloidal gold reactions were negative.

Diagnosis.—A transverse lesion of the spinal cord from pressure of a tumor situated at the level of the second dorsal vertebra.

Operation.—August 25, 1927, under intratracheal ether anesthesia, the spinous processes and laminae of the first four thoracic vertebrae were removed. A flat tumor 3 cms. in vertical diameter, and 1 cm. in transverse diameter, was found lying at the level of the second dorsal vertebra. A moderate degree of compression of the cord was present. The tumor was not encapsulated, was extremely friable, and did not apparently infiltrate the dura or the bone. It was readily removed, and the dura and bony surfaces were then carefully curetted before the wound was closed.

The patient had an uneventful recovery, with gradual complete return of sensation and motor function of the lower extremities, and was discharged from hospital on November 16, 1927.

Pathology.—(M. G. H. S-27-876.) Microscopic examination (Fig. 10) shows a tumor made up of small round cells. In some areas these cells are enmeshed in a finely fibrillar supporting framework. Many blood capillaries are present. In other areas, the stroma is scanty, and tumor cells are loosely intermingled with a small number of branching reticular cells.

The capillaries are delicate, their walls consisting solely of a single layer of endothelial cells. The tumor cells are small, but show some variation in size. (Fig. 11.) They are round, and contain only a small amount of cytoplasm. The nuclei are centrally placed, irregularly round, and deeply stained. Mitosis is rare. There are no eosinophils or fibroblasts.

Diagnosis.—Malignant lymphocytoma (lymphosarcoma).



## MALIGNANT LYMPHOCYTOMA

*Discussion.*—The interest in this case centres upon the diagnosis of the tumor removed from the spinal canal. It is certainly not a primary extradural tumor, since lymphoid tissue does not occur in the spinal canal. If it is to be regarded as a metastatic tumor, its relationship to the tumors of the neck previously operated upon must be considered. In structure it is not absolutely identical with any of these, there being minor differences as regards stroma, vascular elements, and reticulum cells. The tumor cell in each case, however, presents the same characteristics. It is a small round cell with little cytoplasm, and a nucleus which is irregularly round and deeply staining.

*Final Diagnosis.*—A metastatic extradural malignant lymphocytoma of the spinal canal. The primary tumor was a malignant lymphocytoma of the cervical lymph glands first operated upon six years ago.

Metastases of lymphosarcoma within the spinal canal are extremely rare, and little reference to them is found in the literature. One case of primary intestinal lymphosarcoma which showed a secondary diffuse microscopical infiltration of the meninges, is reported by Stürzberg.<sup>7</sup>

Also of interest on account of the intraspinal metastasis, is a case reported by Welch,<sup>8</sup> of Hodgkin's Disease terminating in sarcoma. In this case there had been a paraplegia of many months' duration, and at autopsy a large metastatic extradural mass was found.

Extradural tumors produce changes in the cord by simple compression. At first, the cord is swollen and hyperæmic above the tumor, even though there is no actual destruction of nerve tissue. If the compression continues, however, destruction of the nerve tissue may result. The prognosis, following removal of the tumor, depends upon whether or not nerve tissue has been destroyed. If no actual destruction has occurred, functional recovery is rapid. Occasionally, an acute inflammatory process accompanies the tumor compression, and the prognosis in such cases is less favorable due to the more extensive degeneration of nerve tissue which results.

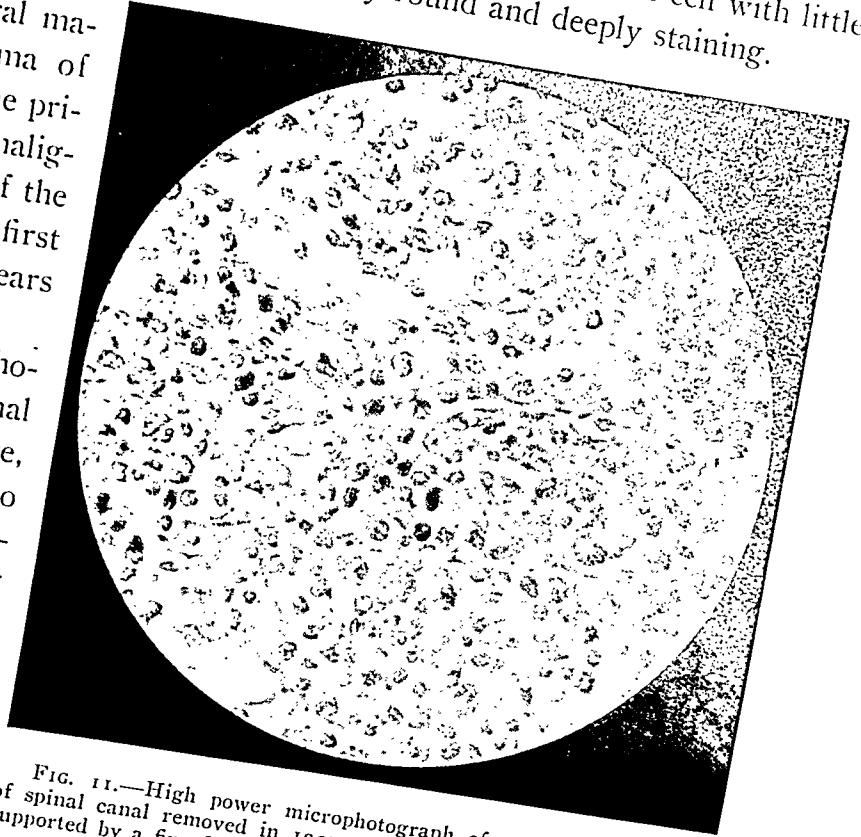


FIG. 11.—High power microphotograph of section from tumor of spinal canal removed in 1927, showing small round tumor cells supported by a fine fibrillar framework.

PHILIP G. SILVER

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# RECURRENT FIBROMATOUS TUMORS OF THE SKIN

By DAVID A. WILLIS, M.D.

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OF CHICAGO, ILL.

CONTRARY to the conventional conception of fibroma, viz.: a benign growth, which does not metastasize and which when enucleated does not recur, there is a fibromatous tumor of the skin which behaves otherwise and which possesses rather characteristic clinical and histological features.

In 1924, Darier<sup>1</sup> described these tumors under what he termed "Progressive and Recurring Dermato-fibromas." In the following year, Hoffman<sup>2</sup> reviewed the literature and reported three additional cases, naming the tumors "Dermato Fibrosarcoma Protuberance." Hertzler<sup>3</sup> in 1926 reported the very same type of tumor, but failed to associate the condition with that described by the previous writers. That recurrent fibromas are not necessarily confined only to the skin is illustrated by the case of Sichel<sup>4</sup> in which, following supravaginal hysterectomy for fibromas of the uterus, there occurred and recurred many times multiple free fibromas in the abdominal cavity, some quite far removed from the site of the original tumors. All the tumors were histologically cellular fibromas, each succeeding new growth being more cellular than the preceding one.

Very recently two cases identical with those in this series have been reported by Senear, Andrews and Willis,<sup>5</sup> which authors to our knowledge are the first to have associated these recurrent fibromas with the type of tumors described by Darier and by Hoffman.

From the few reports in the literature one might think the condition a rare one, but since we have, in a comparatively short time, collected four such cases, we feel that the condition is perhaps generally overlooked. Furthermore, because of the characteristic appearance of the tumors and the tendency to recurrence after removal, we have felt it important to call renewed attention to the condition and report our own cases.

CASE I.\*—Woman aged forty-five years gives the following history: Following a slight injury to the wrist twenty-four years ago, a small nodule appeared on the radial side of the wrist. The mass remained stationary and was removed about six years ago. One year later the tumor recurred, gradually enlarged and was again removed. The present tumor is another recurrence.

There is now present a central spherical tumor mass 3 cm. in diameter, projecting about 8 mm. above the skin surface, with scattered nodular tumors at its base ranging from 5 to 10 mm. in diameter. Over the larger mass, the skin is smooth and glistening and of a reddish-purplish color. The tumors are firm, definitely attached to the skin, but are freely movable over the underlying tissue.

On cut section the structure is uniform and pinkish-white with interlacing strands of more whitish bundles.

\* Case I. Case of Dr. H. M. Richter.

CASE II.†—Woman fifty years of age was operated twelve years ago for a tumor mass in the inner portion of the left breast and also one on the back. About one year ago the tumors began to recur and in the last three months have grown rapidly. There is now present a tumor mass 3 x 5 cm. at the angle of the sternum and left breast. It is hard, freely movable, multilocular and not tender. No axillary glandular enlargements are palpable. A small nodule is also present on the back in the region of the left border of the twelfth dorsal vertebra.

CASE III.—No history could be obtained in this case but the clinical and histological appearance of the tumor warrants its inclusion in this series. The nodular elevations in this growth range from 1 to 5 cm. in diameter, are firm and whitish in appearance (Fig. 1), protrude about 1 cm. above the skin surface, and extend about 3 cm. below the skin surface.



FIG. 1.—Showing the tumor nodules in the skin.

CASE IV.‡—Male patient about forty years of age had several tumors removed from the abdominal wall eight years ago. The growths have since recurred and there is now about ten protuberances on the abdominal wall, varying from 2 to 6 cm. in diameter, firm and whitish in appearance. Some are fairly well fixed, while the majority of the nodules are freely movable.

On cut section the surfaces appear to be composed of white fibrous-like tissue arranged in interlacing bands and whorls. No softening has occurred anywhere.

Histologically the tumors are composed of spindle-shaped cells in a dense fibrous stroma. In some places the connective tissue element is more abundant, while in others

the cellular portion predominates. The nuclei of the cells possess a fairly heavy chromatin network and are somewhat more irregular than in the previous cases. Mitotic figures may be seen here and there. Lacunar-like blood-vessels are present.

The gross and microscopical appearances of all the tumors are so nearly alike that the following description will serve to illustrate the essential features in each.

Grossly the appearance of the nodular elevations varies with the duration and rapidity of the growth. The smaller and younger nodules have as a rule whitish tops, are only slightly elevated and the skin above is neither stretched nor glistening. The larger tumors may have whitish tops when the growth is rapid, but as a rule the color is a purplish-red, particularly in the very slow growing or quiescent elevations with secondary changes in their substance. The skin above is usually smooth and glistening. The individual nodules vary in size from a few millimetres to 4 cm. in diameter, the smallest being only palpable in the skin, but not visible. The elevation above the skin surface varies a great deal and there is no set rule as to this feature. Often they project as reddish spherical masses about 3 cm. above the skin surface. This, however, is no indication of the actual size of the tumor, for they usually extend much farther below than above the surface of the body. They are as a rule fixed to the skin above but are freely movable over the underlying structures. In consistency the younger and faster growing tumors are firm, while the older ones may be soft and even fluctuating.

† Case II. Case of Dr. Emil Beck.

‡ Case IV. Case of Dr. Edmund Andrews.

## RECURRENT FIBROMATOUS TUMORS OF THE SKIN

*On cut section* the structure is uniform and pinkish-white with interlacing strands of more whitish bundles. In the older modules, however, particularly those which are soft and fluctuating, there are often present small hemorrhagic areas and areas composed of a gelatinous-like substance.

*Microscopically* the tumors are composed of spindle-shaped cells with oval regular nuclei possessing a moderate chromatin network. The cells are generally uniform in size and shape, resembling typical fibroblasts, except in the long-standing quiescent nodules where the collagenous intercellular fibrillar tissue is markedly predominant and the individual cells are quite small but still spindle-shaped. Occasionally in such an old nodule an area of active cellular proliferation is present. Here the cells again predominate, are larger and again resemble fibroblasts. (Fig. 2.) They arrange themselves into distinct bundles with a varying amount of intercellular fibrillar tissue. The cells, however, are usually predominant. Mitotic figures are rare. The intercellular tissue shows little affinity to the acid stains. Even with Mallory's aniline-blue method it takes a light blue color, while with Van Gieson's stain the color is a pale dirty yellow. An occasional wide lacunar-like blood-vessel is present. (Fig. 3.) The skin above is not invaded but is stretched and flattened, the papillæ being entirely absent. Areas with mucoid degeneration and small hemorrhages are not infrequent in the old quiescent growths. In such areas the cells appear branched and are separated by a fluid which stains a pale blue with hæmatoxylin. Though a distinct capsule is absent, the tumors are well circumscribed from the surrounding tissue, this being due to an eccentric compression of the adjacent structures. At the base, however, there is a difference in the behavior of the tumor cells, for here they can be seen to break into the subcutaneous fat tissue forming finger-like projections between the fat cells. (Fig. 4.)



FIG. 2.—An area of cellular proliferation in an old tumor nodule.

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*Discussion.*—It is quite apparent how the clinical course and histological appearance of the tumors might lead to a controversy between surgeon and pathologist, if one is not familiar with the condition. The tumors may occur anywhere on the body. There is usually a mother tumor larger than the surrounding elevations, which are apt to be arranged radially and which are often so small as to be hardly visible. The younger or more rapid growths have whitish tops, while the skin over the older ones are purplish-red in color. The masses are usually firm unless mucoid degeneration or hemorrhages in their substance have caused them to become soft and fluctuating. The cut surface is pinkish-white and glistening with prominent interlacing whitish strands. The tumor is attached firmly to the skin above, but can readily be

pulled away from the underlying fatty tissue. This gives the impression of the growth being encapsulated, but the encapsulation is more apparent than real, for as has been seen, the tumor cells actually grow into the subcutaneous fat in finger-like projections, differing in this respect from the common



FIG. 3.--Lacunar blood-vessels in the substance of the tumor.

fibroma. It is evidently these invading portions which after operation account for the recurrences. There is no evidence of metastasis beyond the immediate region of the growth. Microscopically, the cellular element, the lacunar vessels and the staining qualities of the tissues are the characteristic features. Occasionally in a fine fibrillar form of tumor, the cells are arranged in palisade formation. Lauche<sup>6</sup> and also Krumbein<sup>7</sup> have noted that such an arrangement

is indicative of cellular proliferation of mesenchymatous origin, the arrangement according to Krumbein being found particularly in fine fibrillar fibromas, or as he calls them, "fibroma tenui-fibrillare." In this connection it is also interesting to note that Hertzler suggests that the tumors may represent sarcomatous growths derived from adult tissue.

*Treatment.*—The clinical course and histological appearance of the tumors makes a radical removal imperative. As much as possible of the subcutaneous fatty tissue should be removed, the incision in the skin having circled at some distance beyond the edge of the nodules. Where thorough excision is not possible, radiation should be instituted, for since with each recurrence the tumor becomes more cellular, its eventual sarcomatous possibilities must be carefully considered.

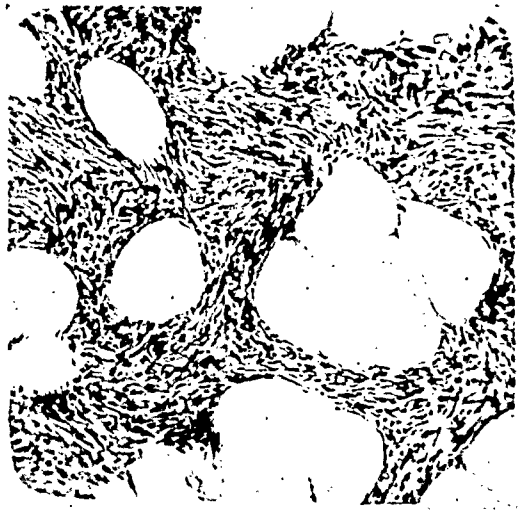


FIG. 4.--Tumor cells penetrating into the subcutaneous fat.

## RECURRENT FIBROMATOUS TUMORS OF THE SKIN

*Conclusion.*—(1) The fibromatous tumors of the skin here described no doubt belong to the same group described by Darier and by Hoffman.

(2) They possess a characteristic clinical and histological appearance.

(3) Radical excision is the only means of preventing recurrences.

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# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD FEBRUARY 22, 1928

The President, DR. FRANK S. MATHEWS, in the Chair

### POLYP OF DUODENUM

DR. WILLIAM B. PARSONS, JR., presented a man, colored, aged forty-one years, who was first seen at the Presbyterian Hospital, November 5, 1927, complaining of indigestion for four months and vomiting for six weeks.

For many years he had had chronic indigestion and he was chronically constipated for at least seven years. About six years before admission he

had an acute episode of abdominal pain and a hemorrhage, at which time he had either vomited or had passed a large bloody stool. Following this attack he was well up to four months before admission. Four months before he came in he noticed that shortly after eating he had sour gaseous eructations accompanied by epigastric discomfort but not real pain. Under treatment he obtained some relief for a time but at the end of three months the previous symptoms returned, getting steadily more severe until just before admis-

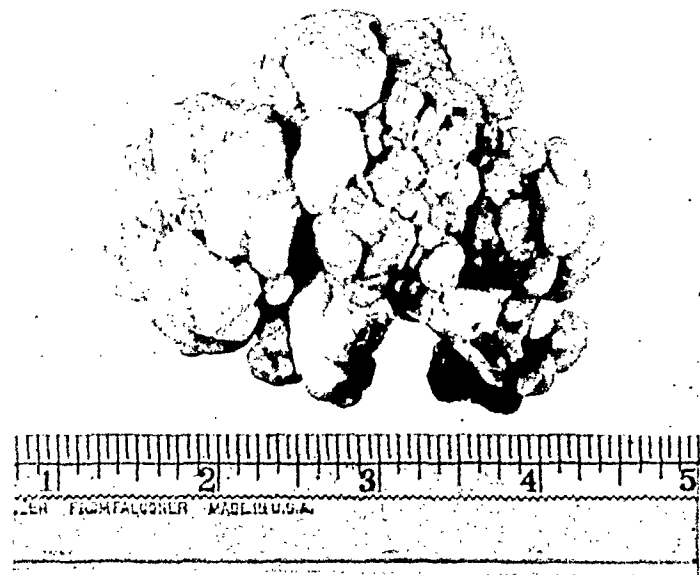


FIG. 1.—Polyp of duodenum. Photograph of specimen.

sion to the Presbyterian Hospital, he had been vomiting immediately after taking fluids or solids and had also had definite gnawing pain brought on by food and relieved by vomiting. There had been no radiation of pain and no vomiting of blood before admission. On admission he weighed 109 pounds, was markedly emaciated and dehydrated. The positive physical findings in addition to his general appearance were in the abdomen where peristalsis was seen at various places. The margin of the liver could be seen about 3 cm. below the costal margin and a vague rounded mass was palpable near the pylorus. His blood was concentrated, the first and many subsequent stools showed a positive guaiac reaction. Gastric analysis showed a free hydrochlorate to 45, total of 61. A gastro-intestinal examination showed a marked pyloric spasm with active peristalsis above the spasm which did not succeed in moving the barium. Amyl nitrite was administered and almost immediately the active peristalsis ceased and the spasm definitely diminished. The pyloric portion then appeared as a narrow line curved to the right, down, backward, and then to the left but demonstration of the bulb was unsatisfactory. The second portion of the



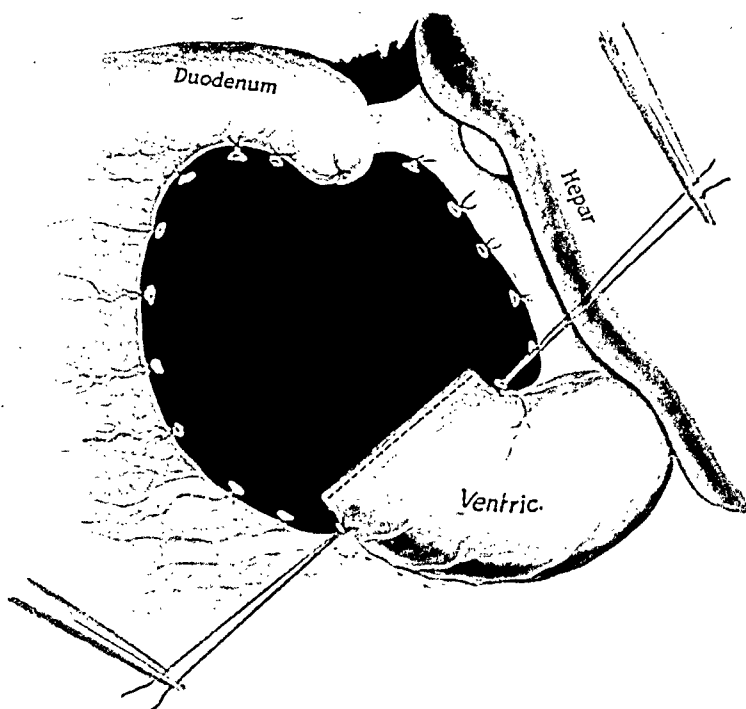


FIG. 3.—Resection of the stomach. Third stage of Billroth II, retrocolica posterior.

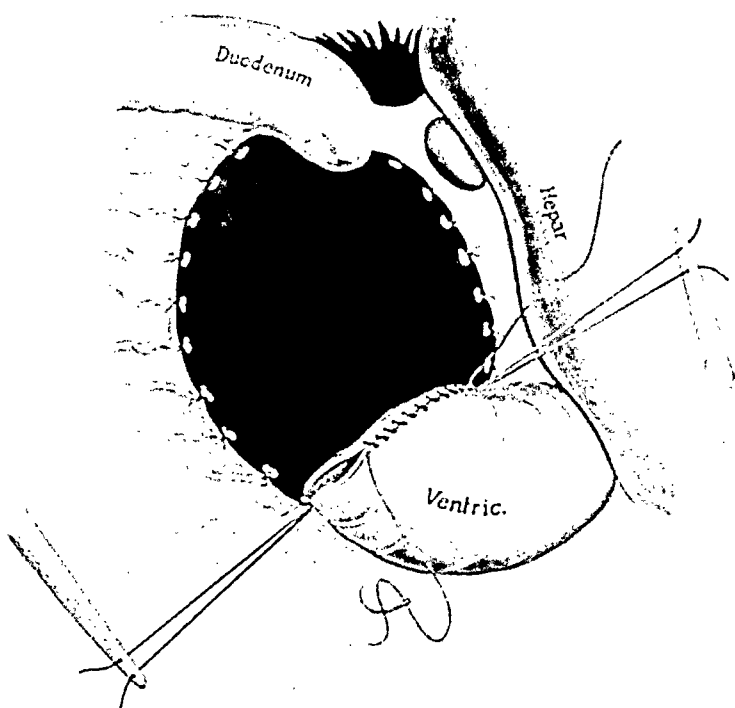


FIG. 4.—Resection of the stomach. Fourth stage of Billroth II, retrocolica posterior.

duodenum was seen and it appeared to be dilated but there was difficulty in passing the barium along. After a month in the hospital his general condition had not improved. The vomiting had become more frequent and was on occasions projectile. Intestinal bleeding had continued, the pain had become more severe and more cramp-like in character. A proctoscopy was done. There was no evidence of colitis found but a single small polyp was removed. He was operated upon on December 13 with diagnosis of duodenal ulcer because of the spasm, pain, tarry stools and bloodless vomiting which seemed best explained on this basis.

At operation a polyp measuring  $8\frac{1}{2} \times 5\frac{1}{2} \times 4\frac{1}{2}$  cm. was found arising from a broad pedicle just behind the pyloric ring. The polyp arose from the posterior wall and had caused a marked dilatation of the first portion of the duodenum. The growth was composed almost entirely of mucous glands and was definitely arising from the mucosa. An anterior incision was made through the pylorus, the pedicle was excised and the wounds in the duodenal and gastric wall were closed.

The patient made a rapid recovery and is shown now, only two months post-operative, not because of any particular difficulties but because of the rarity of the condition.

Benign tumors of the small intestine are relatively infrequent, particularly those of the duodenum. Of the last 2300 autopsies at the Presbyterian Hospital, in three cases duodenal growths were found—in two of them a single mass and in the third several polyps associated with a general polyposis. In the last ten years there are fourteen cases on record in the Surgical Pathological Laboratory of benign tumors of the small intestine, two of these being polyps, one being the case reported and another one a case operated upon by Dr. A. O. Whipple, this polyp being composed almost entirely of Brunner's glands and was almost to be classified as an adenoma.

Dr. Ross GOLDEN has recently reviewed the literature and will shortly publish in the *American Journal of Roentgenology* a report of Doctor Whipple's case together with the review of the literature. He quotes Doering's article in 1907 in which only three of fifty cases of polyposis of gastro-intestinal tract show involvement of duodenum; and also Versé who could find but one case in the large material in the Pathological Institute in Leipzig. The other types of tumor that Doctor Golden mentions in his article are myoma, adenoma and hemangioma.

Dr. WILLIAM C. MACCARTY (Rochester, Minn.) said he had seen two cases of polyp of the duodenum and both were resected. They had been reported by Doctor Pemberton. Neither was as large as the one reported by Doctor Parsons. He had never seen a malignant polyp in the duodenum. Polyp of the wall of the large bowel were more often malignant than they were believed to be a few years ago.

# RESECTION. CARCINOMA OF THE STOMACH. RESULT FIVE YEARS AFTER

Dr. JOHN E. JENNINGS presented a man, fifty-four years of age, who was admitted to the Brooklyn Hospital, March 12, 1923. Chief complaint, pain in epigastrium, digestive attacks for one and a half years. About one year

ago he began to have epigastric pain coming on one hour after eating. It was accompanied by nausea, gaseous eructations and vomiting of the previously eaten food. His sputum was negative. A test-meal showed free HCl, 50, total acidity 80, blood and mucus plus, bile 0, urine acid 1010 and negative for albumin and sugar. The stomach showed at the angle of the lesser curvature a broad filling defect. In most of the films there is an incisura opposite this in the greater curvature. There was considerable gastric residue at five and a half hours. After twelve days of special diet and frequent feedings he was operated on and a mass the size of a walnut was found which involved the lesser curvature of the stomach, the posterior wall, the body of the pancreas and several lymph-nodes. There were several small nodules on the under surface of the liver. A gastrectomy was done using the posterior method of Polya. Examination showed the growth to be malignant, a carcinoma, apparently, on an ulcer base. The convalescence was uneventful and he has remained under observation as an employee of the hospital since his discharge from the ward. He is in good health without pain or dyspepsia. He has not gained much weight but is able to do his work which consists of running an elevator, without any distress. An X-ray of his stomach shows a very small and rapidly emptying organ. He is presented as a case of cancer of the stomach without recurrence five years after operation.

DR. WILLIAM C. MACCARTY recalled a large carcinoma of the stomach which was removed in the Mayo Clinic five years ago; it was an enormous thing. When he opened the specimen he found two pieces of celery as large as his little finger. This patient is still alive and working.

#### SUPPURATIVE PERI-SIGMOIDITIS

DR. JOHN E. JENNINGS presented a man forty-nine years of age, who was admitted to the Brooklyn Hospital, November 11, 1927, suffering with acute abdominal pain, which had begun suddenly thirty hours before. It was generalized for several hours and then gradually became localized in the lower left quadrant. At the time of admission the abdomen showed well marked rigidity and tenderness in both lower quadrants, more pronounced on the left. The temperature was 101, pulse 120, respiration 24. Leucocyte count was 14,800—91 per cent. polymorphonuclear. An immediate laparotomy was performed. A frankly exploratory incision was made just to the right of the median line. A large quantity of foul, purulent fluid was found diffusely generalized. The small intestine was purple and distended. A leaking abscess was found at the pelvic brim on the left side surrounding a gangrenous epiploic appendix. The abscess cavity was opened and cleansed, packed lightly with iodoform gauze and the pelvis well drained with raffia drain tubes. He was placed in bed in the Fowler posture which calls for an elevation on the head of the bed thirty inches. He was given a hypodermoclysis of 1500 c.c. of saline containing 100 c.c. of perfringens antitoxin. Twelve hours later a second clysis was given of 1000 c.c. saline containing 100 c.c. of antitoxin. On the second day after operation he began to vomit stercoraceous material in spite of repeated gastric lavage which was done every four hours. His distention increased, his temperature persisted and his pulse remained about 120. His color, however, remained good and his pupils did not dilate. On the third day he was given 50 c.c. of a 20 per cent. solution of sodium chloride. He also was given eserine and pituitrin. His bowels moved several times and his distention diminished, vomiting ceased and temperature, pulse and respiration began to approach normal. But on the fifth day distention recurred and during a lavage the deeper layers of his wound opened and the intestine

## SYMPATHECTOMY FOR THROMBO-ANGIITIS OBLITERANS

appeared, only retained by the crossed tension sutures. They were promptly replaced by the house surgeon and iodoform gauze placed between the coils of the exposed bowel and the stay sutures. During the next three days his temperature rose to 103, the pulse to 130 with distention, vomiting and abdominal pain. He became irrational and the vomiting again became fecal. He was given 50 c.c. of a 20 per cent. solution of sodium chloride and 1000 c.c. with 200 c.c. of perfringens antitoxin by hypodermoclysis. His bowels moved, his vomiting ceased and he became rational in twenty-four hours. His temperature, pulse and respiration approached the normal. His bowels moved with a good deal of frequency during the next three days after which his convalescence was uninterrupted.

The use of Welch bacillus antitoxin in cases of gangrenous appendicitis with peritonitis was reported in 1922 after two years' experience, and its use as prophylactic in wounds of the colon and operations upon that organ, in rectal surgery and in fecal infection in general was reported. It has since that time been used in France and England where more sera are available than we have at present at our command.

The clinical study of abdominal infection due to anaërobic invasion from the gastro-intestinal tract has been singularly neglected and deserves attention. He hoped to discuss his own experiences more fully at another time. The use of hypertonic salt solution intravenously in cases of ileus was suggested and used by Hayden and Orr following the original studies of Hartwell and Hogue. This case was presented in order to illustrate the very definite use, in certain cases of fecal infection, of an antitoxin prepared against the Welch bacillus and also to report a rather striking instance of an intravenous injection of hypo-tonic salt in intestinal obstruction. He had been lead to begin the use of Welch antitoxin by noting the presence of the Welch bacillus in infections of the abdominal wall following gangrenous appendicitis. Study showed that a fair proportion of fatal cases of appendicular peritonitis revealed the presence of the Welch bacillus in large numbers. It was found that Welch antitoxin in liberal doses was useful.

The experiments of Hayden and Orr suggest that the intoxication of intestinal obstruction is produced by a substance which affects the sodium chloride of the blood stream, absorbing the chlorine, leaving the sodium to circulate as sodium carbonate. This will account for the diminished blood chloride and if it be true, implies that salt is a chemical antitoxin. Clinically it appears to be so. As to the question of why it makes the bowels move, the reply is that probably this is due to the restoration of chloride tension in the tissue where its presence is most keenly missed. Clinically and experimentally intravenous injections of strong solutions of sodium chloride will cause contraction of the obstructed gut. It is safe to use one gram to the kilo of body weight.

## SYMPATHECTOMY FOR THROMBO-ANGIITIS OBLITERANS

DR. JOHN E. JENNINGS presented four cases of threatened gangrene of the foot with several methods of treatment and varying results.

CASE I.—A man, forty-three years of age. Very heavy cigarette smoker. Ten years ago began to have soreness of thumb of left hand. Later toes of

both feet were amputated and left foot also. Present attack eight months ago when he thought his foot had been frost bitten. The first, second and third toes of the right foot were gangrenous. The left leg had been amputated in its lower third. There is an ulcer at its lower extremity.

*Operation.*—Sympathectomy. Incision along the anterior border of the sartorius from a point opposite the upper edge of the patella six inches upward. Muscles retracted, vessel sheath exposed. Many evidences of periarteritis and peri-phlebitis made isolation of artery difficult. Artery was without pulsation. The artery and veins were separated and faint pulsation returned in artery which again ceased as soon as dissection of the wall began. The adventitia was stripped for a distance of three inches. Second and third toes and first phalanx of first as well as ulcer of the stump removed with the high frequency cutting current. Very slow and painful healing. Gangrene arrested. Pain not well controlled.

CASE II.—A. M., Russian Jew, thirty-six years of age, February 7, 1927. Pain in great toe of right foot for four and a half months. Most pain in foot but also in ankle and up to the knee. The toe is white at the tip and purple at the base. The dorsalis pedis, posterior tibial, popliteal arteries cannot be felt in either foot. Sympathectomy with same technic as that just described. Pain was relieved for a short while only. Phlebitis of right femoral vein. Much relieved by hypertonic salt injections and by cutting off cigarettes. Now in a period of remission.

CASE III.—L. E., born in United States of German Christian parents, fifty-three years of age. Six years ago cramps in both feet. Treated for flat feet. Agonizing pain, burning in character in the great toe of the left foot. Amputation of toe three months ago, ulcerating area still very painful. Is an inveterate smoker. *Operation.*—Ligation of femoral artery below the profunda. Immediate gangrene of leg extending to the knee. Amputation in the middle third of the thigh. Guillotine. Subsequent plastic on stump with sloughing of skin flap. Still granulating and almost healed.

CASE IV.—Threatened gangrene of left great toe. Thrombo-angiitis obliterans. I. B., Hebrew, twenty-five years of age. During past winter left great toe was frozen. For past three months has had pain in toe and in the dorsum of the foot. Five weeks ago a small reddened area on the mesial aspect of the distal phalanx of the left great toe broke down and began to slough. There is now an area of painful ulceration. Previous history negative. Is a confirmed smoker of Turkish cigarettes. No pulsation in left dorsalis pedis or posterior tibial. *Operation.*—As in cases previously described. Opening Hunter's canal. Three inch sympathectomy of femoral artery. Relief of pain and healing of ulcer.

In the first case an advancing gangrene of the toes was arrested with slow but complete relief of pain.

In the second case a slowly progressing gangrene was arrested. The pain was not relieved till the hypertonic salt solution was administered, after which pain ceased.

In the third case ligation of the femoral as suggested by Lewis was practiced with immediate loss of the extremity.

In the fourth case, an early case with threatened gangrene, complete arrest of symptoms.

DR. WALTER A. SHERWOOD remarked that the operation of peri-arterial sympathectomy had fallen into a certain amount of disrepute. He felt, how-

ever, that this was due to the misapplication of the operation in unsuitable cases, and that nothing more than palliation or relief of pain should be expected in cases with obstructive lesions of the blood-vessels. In cases, however, in which spasm of the vessels is the underlying factor, as in Raynaud's disease, painful ulcers of amputation stumps and similar conditions, the operation has a distinct field of usefulness and has proved of value in numerous instances. The patient shown here several years ago by Doctor Sherwood, and who had suffered for over twenty years with a painful ulcer of the amputation stump, has remained entirely well since he was subjected to the Leriche operation. In arteriosclerotic gangrene or in thrombo-angiitis obliterans one should not expect anything more than temporary relief of pain.

DOCTOR JENNINGS in closing the discussion said that the operation performed on the four patients shown tonight was more than peri-arterial sympathectomy. Hunter's canal was widely opened in all the cases and a sufficient degree of peri-vascular tension was found to make relief of obstructive pressure on the vessels an important indicator of treatment. It appeared to him that this factor was of some importance. It seemed to him that there were two sorts of pain occurring in these cases; that one was due to spasm of the larger arteries and temporary relief might be expected in these cases as a result of sympathectomy. This pain is paroxysmal, much affected by activity, little by position and hardly at all by temperature changes. The other variety of pain resembles a terminal neuritis, which it probably is. It is much more constant, much more affected by temperature, posture or pressure and is little affected by a sympathectomy. In spite of Berger's brilliant contribution the disease does not apparently always follow the course described by him and thrombo-angiitis obliterans is only one of the pathological changes the essential nature of which is not as yet at all understood.

#### ACUTE PERFORATION OF STOMACH; SUTURE; RECURRENT SYMPTOMS; RESECTION

DR. RICHARD LEWISOHN presented a man, twenty-nine years old, who had been admitted to Mount Sinai Hospital, April 23, 1926, with a history of gastric symptoms for four weeks. Four hours previous to his admission he was suddenly seized with severe cramps in the abdomen, radiating to the right shoulder. He was nauseated but did not vomit. There was a general rigidity of the whole abdomen. Temperature was 100°, pulse 108. Immediate operation was performed by Doctor Stenbuck through a right upper rectus incision. A large amount of pus was found in the upper abdomen with a pyloric perforation. The perforation was closed and the abdomen drained by a rubber dam. Closure of the abdominal wall in layers. He made an uneventful recovery and left the hospital May 7, 1926.

The man was re-admitted, August 22, 1927, having been well for one year following his operation. During the last few months he had complained of heartburn and hunger pains two hours after the meal. X-ray examination showed a deformity of the bulb and reversed peristalsis in the second and third portions of the duodenum. A small residue was noticed on the posterior wall of the duodenum (niche). There was a slight residue in the stomach after six hours. Pre-operative Rehfus test-meal showed free acid 74, combined acids 90.

September 3, 1927 (Lewisohn). Under spinal anæsthesia a midline incision was made from the ensiform process to the umbilicus. Many firm adhesions were found between the omentum and the anterior abdominal wall and between the stomach and the liver and gall-bladder. A puckered scar was noticed at the pylorus (site of the old ulcer). In the posterior wall of the first part of the duodenum a firm, indurated ulcer was felt, adherent to the head of the pancreas and perforating into it. A typical Billroth II resection with a Hofmeister anastomosis was performed. The specimen showed that the ulcer in the first part of the duodenum had perforated into the pancreas and that the head of the pancreas formed the base of the ulcer. Closure of abdomen without drainage. The specimen in addition to the ulcers mentioned above showed a marked gastritis. The patient made an uneventful recovery and was discharged October 1, 1927.

*Reëxamination*, February 1, 1928: Patient is in perfect condition. Rehfus test-meal shows free acid 0, total acidity 12.

#### LATE RESULTS IN PERFORATED GASTRO-DUODENAL ULCERS

DR. RICHARD LEWISOHN read a paper with the above title for which see page 855.

DR. FORDYCE B. ST. JOHN emphasized the error of the old tradition, namely, that an acute perforation of an ulcer, simply treated, necessarily leads to a complete healing. Although follow-up clinics have made this apparent during the past ten years, it is worthy of notice that Doctor Lewisohn's figures show a majority of cases (in a ratio of 20 to 13) relieved of all symptoms.

Before the detailed study of the 39 per cent. "failures," of the thirty-three cases followed, the fact is mentioned that twenty, or approximately 61 per cent., are symptom-free. One must appreciate the importance to the patient of a simple procedure such as was carried out in these cases, from the standpoint of saving life, which after all is the primary object in such an operation at the time it is performed. He did not believe that any experienced surgeon feels that he is doing more than a life-saving procedure, in the presence of a grave complication in a disease the cause of which is unknown, and the treatment of which so debatable.

DOCTOR LEWISOHN has referred in passing to the 34 per cent. of marginal ulcers following gastro-enterostomy at the Mt. Sinai Clinic, and suggests as an explanation that the high percentage is probably due to the fact that the cases are so thoroughly followed. Inasmuch as other follow-up Clinics in which cases are very carefully studied do not show the same high percentage of marginal ulcer, it did not seem to him that this explanation was satisfactory.

The Mt. Sinai Clinic is much the same as the Presbyterian Hospital Surgical Clinic as regards follow-up results in perforated ulcer, as is shown by Doctor Lewisohn's figures. In fifty cases at the Presbyterian during approximately the same period, there were seventeen deaths (two of which were before operation) or 30 per cent. following operation, and of the thirty-three living cases, twenty-seven cases, or 90 per cent., have been carefully followed, the records over a period of from two to ten years showing sixteen cases, or 59 per cent., to be symptom-free.

## LATE RESULTS IN PERFORATED GASTRO-DUODENAL ULCERS

As regards the first of the two main points of Doctor Lewisohn's paper, it must be added that probably the lives of 70 per cent. of these patients were saved by the simple procedure carried out—a point which certainly is not to be minimized.

As regards the second point, that is, the very high percentage of multiple ulcers, the Presbyterian Hospital experience does not corroborate these findings.

As to the conclusions—he did not believe it possible to perform a sub-total gastrectomy in an acute perforated gastric or duodenal ulcer of from six to twelve hours' duration, without incurring a definite risk of mortality. And though he quotes continental observers as advocating this procedure, it seems to him that Doctor Lewisohn is wise in adding, "we believe the mortality would be materially increased", as otherwise one must disregard one's conceptions of the effect of trauma, exposure, duration and extent of surgical procedure as causes of shock.

It would seem to him sounder judgment carefully to follow these cases, and in the event of evidence of recurrence, to then decide on what further operative therapy should be carried out.

DR. CHARLES E. FARR gave a summary of 117 operations for acute perforations of stomach and duodenum performed in the First Surgical Division (Cornell) of the New York Hospital.

No. of cases	No. hours	Deaths	Per cent. deaths	
{ 90	12 hrs. }	11	11.7% (9.5%)	
{ 4	18 }			
9	24 hrs.	2	22.2%	
14	Over 24 hrs.	8	57.1%	
Operative mortality 17.9%				
Type of operation	No. cases	Deaths	2nd operation	3rd operation
Suture of perforation.....	83	18	7* 2† 2‡	2§
Suture and appendectomy.....	21	0	5*	0
Suture and gastro-enterostomy.....	6	1	1*	0
Suture and herniotomy.....	1	0	1*	0
Suture and cholecystectomy.....	3	0	1*	0
Suture and drainage of gall-bladder.	1	0	0	
Gastric resection .....	1	1	0	
Gastro-enterostomy only .....	1	1	0	
(Perforation could not be reached)				

\* Gastro-enterostomy.

† Suture of second perforation.

‡ Resection.

§ Freeing of adhesion.

*Results.*—Twenty-one deaths following operation for acute perforation.

Of the remaining ninety-six cases:

2 were never seen after discharge.

70 had a good result after first operation.

2 cases are too early to include in statistics.

2 unsatisfactory.

20 cases required a second operation.



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*Final results:*—Gastro-enterostomy (sixteen cases).—One case died a year after operation, of pulmonary tuberculosis. No further trouble with stomach. Two cases required a third operation for adhesions. Of these one died after third operation—intestinal obstruction by adhesions. The other case has an excellent result. Thirteen cases have a good result.

Suturing of second perforation (two cases). One case died after second operation (included in twenty-one deaths). One case satisfactory.

Gastric resection (two cases). One case satisfactory. One died after second operation.

DR. JOHN DOUGLAS said that mortality statistics of operations for perforated ulcer are so dependent on the length of time between the perforation and the operation that it is unfair to compare these statistics according to methods.

One thing which had not been considered here this evening, not without bearing on the subject, is that a considerable number of these pyloric ulcers are so close to the pyloric ring that it is difficult to say whether they are gastric or duodenal. In a large indurated ulcer which has perforated, when the sutures are put in through inflamed tissue they sometimes cut through. If the ulcer is excised this, of course, lessens this danger and makes the closure both safer and simpler. If the perforation is near the pyloric ring and a pyloroplasty is done, after excising the ulcer, the pyloric opening is enlarged and the chances of recurrence of symptoms are less. Of course, it must be acknowledged that there are recurrences of ulcer symptoms in a considerable number of cases where a simple closure is done and there are some recurrences of symptoms, although less, if an excision of the ulcer and a pyloroplasty are employed. However, reports have been made of symptoms recurring after a subtotal gastrectomy and two cases have been reported from the Mayo Clinic of renewed ulceration after such an operation. Before accepting this radical operation as a positive cure surgeons should wait a little while longer.

DOCTOR LEWISOHN, closing the discussion, said that he did not advocate subtotal gastrectomy in acute perforated gastric or duodenal ulcer. What he had wanted to point out was that these cases should be carefully followed and one should not feel when they were sent home that they were cured. A large number recur; if they are not relieved of their symptoms in six months they should be subjected to more radical procedures.

# BRIEF COMMUNICATION

## CRITIQUE ON ADRENALECTOMY FOR ALLEGED HYPERADRENALINEMIA

CONCERNING the report by the Russian surgeon, Oppel, entitled "Adrenalectomy for Hyperadrenalinemia in Spontaneous Gangrene," appearing in this number of the *ANNALS OF SURGERY* (vol. lxxxvii, No. 6, June, 1928, p. 801), which has been referred to us for criticism, we feel that all reliable experimental evidence, at present available, must lead one to condemn such a procedure on human beings. The proof accepted by Oppel and his collaborators, to support the idea that certain clinical conditions are associated with an excess of circulating adrenalin, is inadequate and the conclusions unwarranted. We base our criticism chiefly on the evidence afforded in the recently published paper by one of his assistants, Achutin, in the *Ztschr. f. d. ges. exp. Med.* (1927, vol. lvi, p. 698). From this article it appears that these investigators ignore, or are apparently not familiar with the *quantitative* studies, made by *quantitative* methods, on the rate of adrenalin discharge from the adrenal glands. In reaching their conclusions, they have employed the reactions of the isolated strip of cat's intestine to adrenalin.

The sympathomimetic effect, of adrenalin in effective concentrations, (*i.e.*, the same effect as is produced by stimulation of sympathetic nerve supply) on an intestine segment is inhibition of contractions and diminution of tone. This reaction is useful in making studies on the amount of adrenalin in blood and the reaction, when properly employed, yields satisfactory information concerning the concentration of adrenalin present. But from the above-mentioned article it appears that the writer has accepted rather crude *qualitative* reactions as a basis for *quantitative* interpretations. Reference to any of the large number of papers by Stewart and Rogoff, on quantitative measurements of adrenalin secretion under various conditions, will show that Achutin does not apply the method properly for quantitative studies. We have found the isolated rabbit's intestine segment more satisfactory than cat's and for very low concentrations of adrenalin in blood, the reaction, when doubtful, is always confirmed by utilizing a segment of rabbit's uterus (non-pregnant) which yields an effect opposite to that obtained on the intestine (*i.e.*, increase of tone and contractions). By the use of isolated segments of these two organs we have detected, with certainty, concentrations of adrenalin as low as 1:100,000,000 to 1:1,000,000,000 in blood or serum.

In a number of attempts made by us to detect adrenalin in the systemic blood, we have been unable, thus far, to obtain any definite reaction. This is not surprising since the epinephrin-containing blood from the suprarenal vein is diluted at least 200 times before reaching the general circulation and even on

the assumption that none of the epinephrin is destroyed in the pulmonary circulation (an assumption that is by no means justifiable) the concentration of adrenalin in systemic blood, under normal conditions, would probably be at most 1:1,000,000,000 to 1:2,000,000,000. However, in adrenal vein blood, where the concentration is within the limits capable of detection by our method, we have been able to make extensive quantitative studies on the rate of secretion.

From very inadequate tests, these Russian writers have been led to assume the existence of hyperadrenalinemia in such conditions as Raynaud's disease and spontaneous gangrene, and on the strength of what we feel are erroneous interpretations, have repeatedly operated upon human beings and removed one adrenal. Even if it were possible to consider the evidence offered by Achutin as valid and all the reactions observed by him as genuine adrenalin reactions, we feel that his conclusions are not warranted, owing to apparent lack of critical analysis of the alleged results. Since, if the reactions are interpreted as evidence of such concentrations of adrenalin in the systemic blood as he believes to exist, a simple arithmetical calculation would, at once, show that this is not only quite improbable but perhaps impossible. For, it would mean that the adrenalin concentration in the adrenal vein blood must be about 1:100,000 to 1:250,000. From the large number of quantitative studies made by us on the rate of adrenalin secretion from the adrenal glands, we consider the existence of such concentrations of adrenalin in the adrenal vein blood as highly incredible. Blood containing such concentrations of adrenalin being constantly discharged into the circulation, at the rate of blood flow that exists in the adrenal glands, would unquestionably produce tremendous reactions and would probably soon lead to a fatal outcome. It must be repeated that, in our opinion, excision of adrenals, in human beings, is too dangerous a procedure to undertake on the strength of these investigations, and should be deprecated.

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#### EDITORIAL ADDRESS

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cases blood could be found after the operation in the expectoration of the patients. It was found that of the 58 cases treated by means of the de Petz instrument there were only 8 in which bloody expectoration could be noted after operation while in the 34 cases operated on according to the original hand-sewing method, we have observed in 7 cases larger quantities of blood in the post-operative expectoration of the patients.

Concerning the 58 cases of resection mentioned, the de Petz stomach and intestinal sewing apparatus was successfully employed in applying the provisional occluding suture in 10 cases of carcinoma of the stomach, in 17 cases of pyloric ulcer, in 30 cases of duodenal ulcer, and in one case of *ulcus ventriculi tbc.*

The passage was reëstablished in all cases by means of gastrojejunostomy, in 56 cases Billroth II retrocolica posterior and in 2 cases Billroth II oralis sec. Reichel-Polya being resorted to.

As the result of our ample and favorable experiences in above cases of resection, the use of the de Petz sewing instrument for the provisional occlusion of broad stomach and intestinal cavities became the rule in our clinic, and, in full agreement with de Petz, Klaus, and Taddei, I can summarize the main features of the instrument as follows: 1. Extremely simple to use. 2. Unlimited durability and unsurpassed simplicity. 3. Essential reduction of the operating time, which in gastro-intestinal operations is of utmost value. 4. Perfect asepsis. 5. The clip row is regular and waterproof. 6. The application of the sero-serous inturning suture of the stump is remarkably easy and simple. 7. The clips are naturally evacuated in the stool of the patient without causing any trouble. 8. By means of the instrument the resection of a carcinomatous stomach can be carried out much higher toward the cardia, *i.e.*, much more radically. 9. Filling of the instrument is very simple. 10. The hæmostatic effect of the clip row is very good and sufficient. It happens from time to time that in cutting through the furrow: one or two small arteries which have accidentally been situated between two clips have to be ligated, which, however, causes no trouble nor any danger nor any appreciable loss of time.

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# CARCINOMA OF THE OVARY IN INFANCY\*

By VERNE C. HUNT, M.D.

AND

HAROLD E. SIMON, M.D.

OF ROCHESTER, MINN.

FROM THE DIVISION OF SURGERY OF THE MAYO CLINIC

THE case reported is of special interest because the patient is younger than any with carcinoma of the ovary that we have noted in the literature.

REPORT OF CASE.—The patient was a baby girl aged seventeen months. She had appeared normal at birth and had been well until six weeks previous to examination at the Mayo Clinic, when pertussis had developed. One month before there had been a slight blood-tinged vaginal discharge resembling menstrual flow. This lasted for only a few days but reappeared three days previous to examination. The mother had noted also that the breasts were unusually large and that there was an excessive amount of pubic hair. There had been moderate loss of weight. Two weeks before a mass had been felt in the abdomen, which was enlarging rapidly and had already reached the level of the umbilicus.

The child was about normal size for her age but her development corresponded to that at puberty. The breasts and external genitalia were overdeveloped. There was a fine growth of hair in the axillae and on the labia, and a rather heavy growth of coarser, slightly pigmented hair over the mons veneris. A slight blood-tinged vaginal discharge was present. There was no evidence of mental precocity. A large, smooth, freely movable mass occupied the middle of the abdomen. The urine was normal; the leucocytes numbered 16,700 and the differential count was normal. Abdominal tumor, probably of ovarian origin, was diagnosed and exploration was advised.

The abdomen was opened through a long right rectus incision. There was about 1500 c.c. of ascitic fluid in the peritoneal cavity, and a large, firm, well-encapsulated tumor of the right ovary. There was no evidence of metastasis and the left ovary and the uterus appeared normal. The tumor and the right Fallopian tube were removed. Convalescence was uneventful and the baby was dismissed from the hospital on the tenth day. At that time the size of the breasts had decreased slightly.

The tumor weighed 1000 gm.; it was oval, measured 11 by 15 cm., and was surrounded by a smooth, grayish-white capsule which was not invaded by it at any point. The tumor was composed of moderately firm, grayish-white tissue, with multiple, small, smooth-walled cysts scattered throughout (Fig. 1). Microscopically two types of structure were present; a solid type predominated (Fig. 2) in which the cells had no uniform arrangement. The individual cells were moderately large, polyhedral, and had large, dark-staining nuclei. Mitotic figures could be seen in nearly every field. In a few areas there was glandular arrangement with papillary ingrowths (Fig. 3). Carcinoma of the ovary associated with multiple cysts was diagnosed.

Comment.—Masson and Ochsenhirt have recently reviewed 564 cases of malignant tumor of the ovary treated surgically in the Mayo Clinic from 1916 to 1926, inclusive. In this series there were five patients aged less than twenty years; the youngest was eight, two were fifteen, one sixteen, and one seventeen. All of the tumors were carcinomatous.

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## CARCINOMA OF THE OVARY IN INFANCY

Wiel, in 1905, noted in the literature twenty-four cases of ovarian tumor in children aged less than five years. There were seven cases each of simple cyst, dermoid cyst, and sarcoma, and one case each of teratoma, cystadenoma, and papillary cyst. Downes, in 1921, noted twenty-six additional cases of ovarian tumor in children aged less than ten years. Two of these were simple cysts, eight were dermoid cysts, and sixteen were malignant tumors.

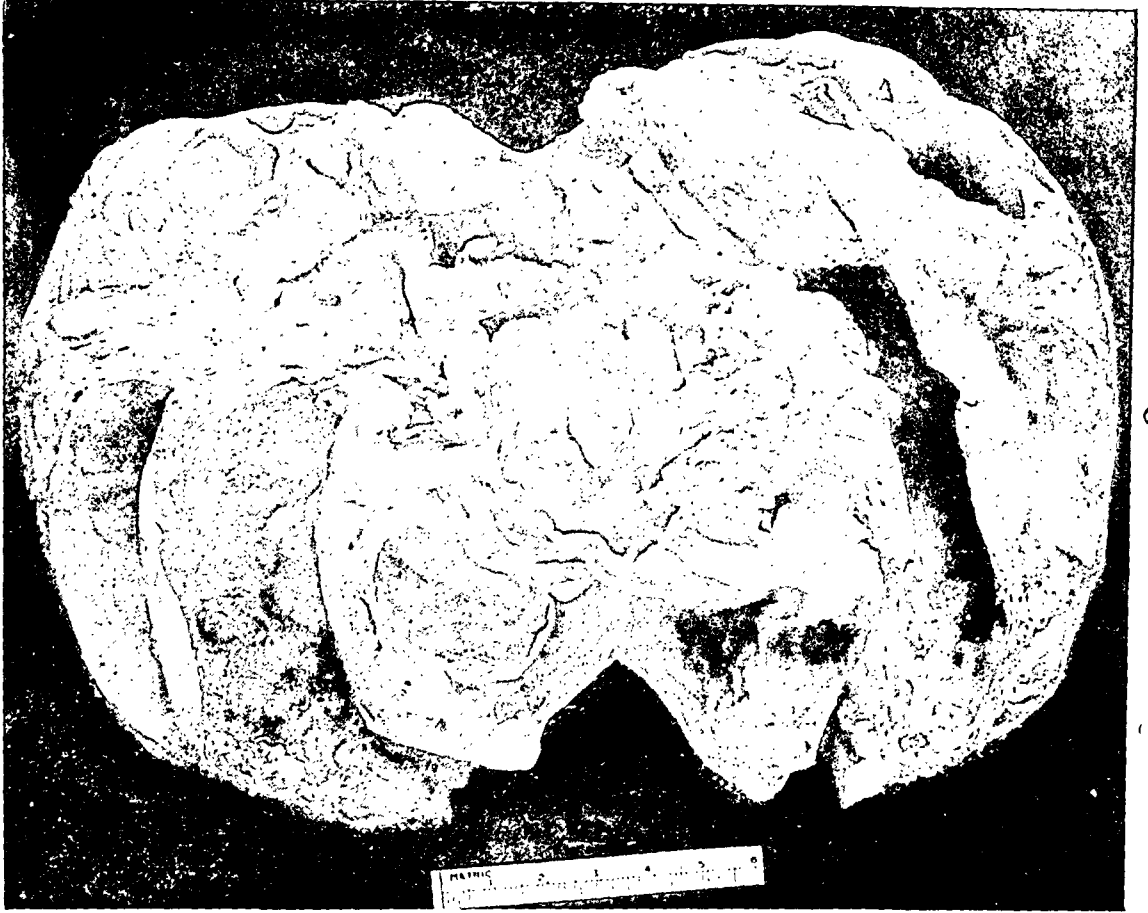


FIG. 1.—Cross-section of ovarian tumor removed from an infant aged seventeen months.

In these two series the benign and malignant tumors occurred with about equal frequency.

Simple cysts of the ovary have been found in very young infants in a number of instances; Wiel noted two cases in the literature of infants of three and four months, and Downes, one at seven months. In the infants of four and seven months the symptoms had been present since birth. Sarcoma has been noted relatively often in the very young; by Doran in a seven months' fetus, by Downes and Knox, and by Harris in infants of twenty-two months, and by Hoffman in an infant of thirty-three months. Dermoid cysts noted in early infancy are usually small and slow growing and produce few symptoms before puberty. Carcinoma of the ovary is extremely rare in patients aged less than five years. We have not been able to find a case recorded in which carcinoma occurred earlier than in the case we have reported; although Downes and others have reported cases in which carcinoma of the ovary occurred at five years.

*Symptoms and Diagnosis.*—The symptoms of carcinoma of the ovary in children and infants are general and special. The general symptoms consist of the presence of an abdominal tumor which usually increases in size rapidly and is often discovered accidentally. It occupies the abdominal rather than the pelvic cavity because in children the uterus and adnexa are abdominal and not pelvic organs. For this reason, Downes has pointed out that symptoms from pressure on the bladder and rectum are seldom present. There is usually accompanying loss of weight. Pain is associated only with torsion, with

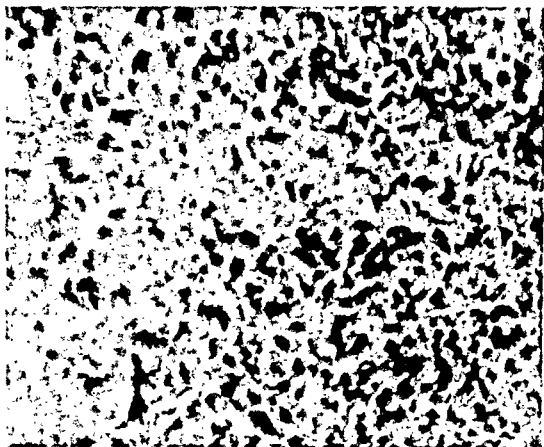


FIG. 2.—Solid arrangement of cells which predominated in the ovarian carcinoma. (x 120.)

intestinal obstruction, or with enlargement of the tumor. Anemia, diarrhoea or constipation, emaciation and symptoms arising from metastatic growths, are late occurrences.

The special symptoms associated with ovarian carcinoma and with other types of ovarian tumor in children are those of *pubertas præcox*. This is true homosexual precocity; the breasts and external genitalia develop and changes in fat distribution occur over the body in a manner similar to that which is normal at puberty. Pubic, labial and axillary hair appears. Menstruation is initiated as at puberty. Mental precocity is not present in these cases, the mental age corresponding as a rule to the age of the child.

While sexual precocity has been observed with other conditions, and especially with tumors of the pineal gland and the suprarenal cortex, variations exist which usually suffice to make the differential diagnosis. With tumors of the pineal gland, according to Reuben and Manning, precocious sexual development may occur, but since these tumors have been observed in the male in almost every instance in which the diagnosis has been proved at necropsy, there is little chance of confusing them with ovarian tumors. Moreover, pineal tumors are associated sooner or later with the clinical signs and symptoms of cerebral tumor, and abdominal tumor is, of course, lacking.

With tumor and hyperplasia of the suprarenal cortex the sexual precocity is of the male type. If the patient is a male, the masculine characteristics are accentuated, if a female, the precocity is heterosexual in type and consists of hypertrichosis, enlargement of the clitoris and, often, change in voice; however, the early appearance of menstruation is not a feature.

It is doubtful whether sexual precocity occurs in association with pathologic changes in other glands of internal secretion. Leiner, Reuben and Manning, and others, who have investigated this problem, deny it. Ovarian hyperfunction not associated with ovarian neoplasm may present the syn-

drome of *pubertas præcox*, but in these cases there is no associated loss of weight and no tumor can be palpated in the abdomen. Cases thought to be of this nature should be observed frequently and carefully to rule out ovarian neoplasm of slow growth.

While it is usually possible to make the diagnosis of ovarian tumor on the symptoms and clinical data, it is seldom possible to determine clinically the type of neoplasm. Simple cysts, dermoid cysts, teratomas, sarcomas, and carcinomas of the ovary have all been observed in association with *pubertas præcox* and there are no characteristic clinical data that enable one to make the differential diagnosis. Other conditions which may simulate ovarian tumors are renal neoplasm, mesenteric cyst, and abdominal ascites, and in those cases in which the ovarian tumor is not associated with sexual precocity it may be impossible to make the diagnosis.

*Treatment and Prognosis.*—The treatment of ovarian tumors of any type, in infancy and childhood, is surgical. The only point on which a question arises is the advisability of removing the unaffected ovary. Until more cases have been reported with records of the ultimate outcome, it will be impossible to settle this question definitely. There is not enough evidence at present to justify the removal of an apparently normal ovary from a child in the presence of a malignant tumor in the other ovary. If the tumor is benign, the operation should, of course, be as conservative as possible.

These patients withstand operation well and following the removal of the tumor the symptoms of precocity usually subside rapidly. There is not sufficient data available on which to base an opinion in regard to the ultimate prognosis. In those few instances in which post-operative records have been available, the subsequent course has usually been favorable, depending of course on the duration and extent of the growth at the time of the operation, and especially on the degree of malignancy of the neoplasm.

The mechanism of the stimulus to the development of sexual precocity in these cases is not known. There are two plausible hypotheses in regard to this mechanism in the case of ovarian tumors: that the neoplastic growth acts as a non-specific stimulus to hyperactivity of the normal ovarian tissue, and that the neoplastic tissue itself functions. That the latter is not true in all cases, at least, is indicated by the occurrence of sexual precocity in association with simple cysts in which there is presumably no neoplastic ovarian tissue. We know, however, that neoplastic tissue in other organs is capable



FIG. 3.—Glandular structure characteristic of portions of the ovarian carcinoma. (x 60.)

of functioning to a limited extent, and that this occurs in inverse ratio to the degree of the malignancy. It is reasonable to conclude, therefore, that this may be true of ovarian tumors, especially those of carcinomatous type.

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